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<b>(21) International Application Number:</b> PCT/US88/01112 <b>(22) International Filing Date:</b> 6 April 1988 (06.04.88)  <b>(31) Priority Application Number:</b> 101,652 <b>(32) Priority Date:</b> 28 September 1987 (28.09.87) <b>(33) Priority Country:</b> US  <b>(71) Applicant:</b> ALLIED-SIGNAL INC. [US/US]; Law Department (C.A. McNally), P.O. Box 2245-R, Morristown, NJ 07960 (US).  <b>(72) Inventors:</b> HANGEY, Dale, Alan ; 629 Glenmeadow Road, Midlothian, VA 23113 (US). HARRIS, Paul, Wesley ; 2321 Hey Road, Richmond, VA 23224 (US). CORCORAN, Daniel, Joseph, Jr. ; 912 Westcreek Drive, Richmond, VA 23226 (US). FRIEDBERGER, Michael, Philip ; 1726 Berkeley Avenue, Petersburg, VA 23805 (US). COLE, Charles, Jayroe ; 11560 Teterling Road, Chester, VA 23831 (US). ARCHIE, William, Alexander ; 1911 Walker Avenue, Petersburg, VA 23803 (US). SPITZ, Roger, Neil ; 601 West 113th Street, Apartment 8F, New York, NY 10025 (US).		<b>(74) Agent:</b> WINTER, Richard, C.; Allied-Signal Inc., Law Department (C.A. McNally), P.O. Box 2245-R, Morristown, NJ 07960 (US).  <b>(81) Designated States:</b> AT (European patent), AU, BB, BE (European patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH (European patent), CM (OAPI patent), DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB (European patent), HU, IT (European patent), JP, KR, LK, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL (European patent), NO, RO, SD, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent).  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> METHOD TO ENHANCE STAIN RESISTANCE OF CARPET FIBERS  <b>(57) Abstract</b>  This invention relates to improved methods to enhance stain resistance of dyed nylon carpet fiber by a continuous aftertreatment and to two-step processes, either batch-batch, batch-continuous or continuous-continuous. After preheating with water and extracting to a wet pick-up of between 30 to 190 % by weight, sulfonated aromatic condensates which can be combined with fluorocarbon compounds for soil resistance, thiocyanates, and/or salts having divalent cations, such as magnesium sulfate are applied. Also various dispersing agents, buffering acids and sequestering agents are disclosed.		

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Method to enhance stain resistance of carpet fibersBACKGROUND OF THE INVENTION

This invention is related to improved methods and compositions to enhance stain resistance of carpet fibers. Sulfonated aromatic condensates alone in a new process or in combination with other compounds are used to improve stain resistance. Related technology is disclosed in commonly assigned, copending applications Serial No. 889,705 filed July 28, 1986, on sulfonated benzotriazoles and Serial No. 074,487 filed July 23, 1987, on sulfonated aromatic formaldehyde condensates, such as diphenyl ether condensates.

The following terms are defined for use in this specification.

By sulfonated aromatic condensate (s.a.c.) is meant any condensate of an aromatic compound whether sulfonated prior to or after condensation, particularly sulfonated aromatic formaldehyde condensate (s.a.f.c.), effective to enhance stain resistance of fiber or carpet fabric.

By thiocyanate is meant any salt, organic or inorganic, containing a cation and the thiocyanate anion.

By fluorocarbon is meant those fluorocarbon compounds effective to improve the antisoiling properties of fiber or carpet fabric.

By ICP is meant index of crystalline perfection, a measured indication of the internal crystal structure of the polymer in an oriented fiber. High ICP indicates an open crystalline internal structure, easily dyeable polymer fiber.

By nylon is meant the polyamide family of polymers, nylon 6, nylon 6,6, nylon 4, nylon 12 and the other polymers containing the  $\begin{array}{c} \text{[C-N]} \\ \parallel \quad | \\ \text{O} \quad \text{H} \end{array}$  structure along with

the  $\text{[CH}_2\text{]}_x$  chain.

By carpet fabric is meant carpet fiber or yarn which has been typically tufted, woven, or otherwise

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constructed into fabric suitable for final use in home furnishings, particularly as floor covering.

By fiber is meant continuous filament of a running or extremely long length or cut or otherwise short fiber known as staple. Carpet yarn may be made of multiple continuous filaments or spun staple fiber, both typically pretextured for increased bulk.

By salt having a divalent cation is meant any such salt effective to enhance stain resistance of fiber, particularly high ICP nylon fiber, when combined with an effective amount of a s.a.c.

By dispersing agent is meant any chemical compound or combination of chemical compounds effective to make stable, relatively nonprecipitating, noncoagulating mixtures of other chemical compounds.

By sequestering agent is meant any chelating agent which is effective in sequestration, which is the suppression of certain properties of a metal without removing it from the system or phase. To be practical, the sequestering agent must not cause any undesirable change that would render the system unsuitable for its intended purpose. Chelation produces sequestration mainly by reducing the concentration of free metal ion to a very low value by converting most of the metal to a soluble chelate that does not possess the properties to be suppressed.

A chelating agent is a compound containing donor atoms that can combine by coordinate bonding with a single metal atom to form a cyclic structure called a chelation complex or, simply, a chelate. Because the donor atoms are connected intramolecularly by chains of other atoms, a chelate ring is formed for each donor atom after the first which coordinates with the metal. The above is from Volume 5, beginning page 339, of the Kirk-Othmer Encyclopedia of Chemical Technology (John Wiley & Sons), 1979, hereby incorporated by reference to p. 367.

It is known to use sulfonated aromatic formaldehyde condensates ("s.a.f.c."s) in the yarn finish (during

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or after fiber quenching) to improve stain resistance of carpet fiber, see U.S. 4,680,212, in the dye bath for the same purpose, see U.S. 4,501,591 or incorporated into the fiber for the same purpose, see U.S. 4,579,762. All three  
5 above U.S. patents are hereby incorporated by reference, in toto. Use of fluorochemical to improve both stain and soil resistance in combination with s.a.f.c.'s is also taught in U.S. 4,680,212, column 5. Other useful fluorochemicals for antisoiling are taught in commonly assigned  
10 U.S. 4,192,754; 4,209,610; 4,414,277; 4,604,316; 4,605,587 all also hereby incorporated by reference, in toto.

It is known to use thiocyanates, such as ammonium thiocyanate, at different process conditions as  
"assists" during dyeing for various purposes. See U.S.  
15 3,652,199; 3,576,588; 3,387,913; 2,899,262; and 2,615,718 all hereby incorporated by reference, in toto.

Use of salts containing a divalent cation, such as magnesium sulfate, with s.a.f.c.'s to improve wet fastness is known in U.S. 3,790,344, hereby incorporated by  
20 reference, in toto. Also see page 48 of a textbook by Rosen, M. J., Surfactants & Interfacial Phenomena (Wiley, 1978).

It is also known generally to use acid, including citric acid to buffer a dye bath and to use  
25 dispersing agents and/or sequestering agents to stabilize a aqueous formulations of chemicals.

Nylon carpets may be permanently discolored or stained by certain artificial colorants, such as food dyes, or oxidizing agents, such as acne preparations  
30 containing benzoyl peroxide. S.A.C.'s, applied to the fiber to provide an ionic barrier to food colorants, make the fiber more stain resistant, but are not effective against oxidizing agents. Furthermore, many of the s.a.c.'s used commercially for the preparation of "stain  
35 resistant" carpets are themselves, susceptible to oxidation upon exposure to light and ozone. This results in a yellowing of the s.a.c. and subsequent destruction. This has a major impact on the carpet properties. The

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yellow color of the s.a.c. results in a perceptible shift in the color of the carpet. Destruction of the s.a.c. results in a loss of the stain resistance properties of the carpet.

5           Use of fluorocarbon compound treated nylon fiber in carpet fabric inhibits wetting of the fiber surfaces which also inhibits any staining agent from being adsorbed onto or absorbed into the fiber. This surface wetting inhibition can be insufficient when the staining agent is  
10       dropped on the carpet with enough force to break the surface energy of the fluorocarbon surface barrier or not cleaned from the carpet and left in contact with fibers for extended time. Carpet treated with compositions containing s.a.c.'s must not interfere with the  
15       antisoiling properties of the fluorocarbon.

          Application of s.a.c. to the carpet fabric must be effective, economical, and compatible to both untreated and fluorocarbon treated fiber, and to both continuous dyeing and Beck or batch dyeing. The same is true of any  
20       s.a.c. application formulation. The s.a.c. formulation must achieve effective penetration into the carpet fabric. Exhaustion of the individual active chemical components of any s.a.c. formulation must also be effective if not complete.

25           Certain nylon polymer fibers have very open internal crystal structure, namely high ICP polymer fiber, which require large amounts of s.a.c. to impart an effective degree of stain resistance. High ICP polymers are usually the result of high temperature saturated steam  
30       heat setting processes.

          Some prior compositions and methods are only marginally acceptable regarding durability of the stain resistance when the carpet is steam cleaned with a detergent at a high pH.

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#### SUMMARY OF THE INVENTION

          This invention is several interrelated embodiments wherein the several new s.a.c. application formulations are used in the several new application

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processes. First described is a continuous aftertreatment for dyed nylon carpet fabric, using several combinations of chemical compositions to apply a s.a.c.. Then the two-step process of treating carpet fabric with a s.a.c., still using the continuous aftertreatment as the second step is described. This includes batch (or beck)-continuous and continuous-continuous two-step treatment. The combination of s.a.c. and the thiocyanates, and with various added chemicals, to improve resistance of dye and s.a.c. on the fiber to oxidation is next described. Then the method to improve stain resistance of nylon fiber, particularly high ICP fiber, using s.a.c., thiocyanate and a salt having a divalent cation and with additional added chemicals is described. The method to improve light induced yellowing of s.a.c. treated fiber by buffering with citric acid or any acid with a sequestering agent is an embodiment described throughout and specifically at this point. Then the new two-step batch-batch process is described used with various formulations. Finally described is an improved method to exhaust thiocyanate at low pH.

The first embodiment of this invention is a method to continuously treat dyed nylon carpet fabric to impart improved resistance to staining comprising preheating the dyed carpet fabric with water at a temperature of between about 140 and 212°F (60 and 100°C) to a wet pick-up of above about 75% by weight, and a carpet temperature of between about 130 and 210°F (54.4 and 99°C), then extracting the water from the carpet fabric to a wet pick-up of between about 30 to 190% by weight, then applying an aqueous solution of an effective amount of a sulfonated aromatic condensate to the carpet fabric at a pH of between about 1.5 to 5.5, at a concentration of between about 0.25 and 40 grams of solids of said condensate per liter of aqueous solution, at a wet pick-up between 200 and 650% by weight, an aqueous solution liquor of between about 140 and 212°F (60 and 100°C) to achieve a carpet fabric temperature between

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about 130 and 210°F (54.4 and 99°C), then holding the carpet in the aqueous solution for between about 0.5 to 90 seconds at a temperature above 130°F (54.4°C). The carpet fabric can subsequently be washed in water. The preferred sulfonated aromatic condensate has been condensed with formaldehyde. The method of extracting can be by applying vacuum to the wet carpet fabric or by squeezing the wet carpet fabric with a pair of rollers. The preferred concentration of the condensate is between about 0.25 and 10 grams per liter of aqueous solution. The preferred wet pick-up of the aqueous solution is between about 300 and 600% by weight. When the aqueous solution is applied by pressurized contact with the carpet fabric, the wet pick-up preferred maximum is 450%. When the aqueous solution is applied by spray, the preferred wet pick-up minimum is 400%. It is preferred that the carpet fabric be held in the aqueous solution for between about 2 and 30 seconds. The preferred wet pick-up after extracting is between about 50 and 150% by weight. The sulfonated aromatic formaldehyde condensate can be formed by condensation of formaldehyde with one or more phenols. At least one of the phenols can be phenol sulfonic acid or the alkali metal salt thereof. It is preferred that one of the phenols be dihydroxy aromatic diphenylsulfone. It is most preferred that the condensate be formaldehyde condensed with the alkali metal salt of para-phenol sulfonic acid and with 4,4'-diphenylsulfone. The beginning dyed carpet fabric of this process may also comprise an effective amount of a fluorocarbon compound intended to improve resistance to soiling of the carpet. The preferred amount of fluorocarbon present is an amount of from about 0.05 to 0.4% by weight of the fabric. The fluorocarbon can contain perfluoroalkyl radical or can be a mixture of fluorinated pyromellitate oligomers. A more preferred fluorocarbon is a mixture of pyromellitate oligomers formed by two reactions, first, the reaction of pyromellitic dianhydride with the fluorinated alcohol, and second, the reaction product of the first reaction further



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reacted with epichlorohydrin. Another preferred fluorocarbon is a reaction product of a perfluoroalkyl alcohol or amide with a suitable anhydride or isocyanate. Another more preferred fluorocarbon is a reaction product of N-ethyl perfluorooctyl-sulfoamideo ethanol with toluene diisocyanate. The aqueous solution of this method may also contain an effective amount of a thiocyanate. The thiocyanate cation may be ammonium, sodium, potassium, copper, zinc, ferrous, ferric, methyl or phenyl, preferred is ammonium. The aqueous solution of this method may also contain an effective amount of a dispersing agent. The dispersing agent can be a condensed naphthalenic salt, alkyl sulfosuccinate or mixtures thereof. The preferred dispersing agent is a mixture of a sodium salt of condensed naphthalenic sulfonic acid and di-isobutyl sulfosuccinate. The aqueous solution of this method may also contain an effective amount of a salt having a divalent cation. The preferred salt is calcium, magnesium, zinc, or ferrous chloride, sulfate or phosphate wherein the most preferred is magnesium sulfate. The preferred aqueous solution would contain the combination of a sulfonated aromatic condensate, a salt containing a divalent cation, a thiocyanate, and a dispersing agent, the most preferred combination would be wherein the condensate is formaldehyde condensed with the alkali metal salt of para-phenol sulfonic acid and with 4,4'-diphenol-sulfone, the thiocyanate is ammonium thiocyanate, the divalent cationic salt is magnesium sulfate and the preferred dispersing agents are di-isobutyl sulfosuccinate and the sodium salt of condensed naphthalene sulfonic acid in a mixture. The preferred carpet fabric would comprise a fiber treated with a fluorocarbon. The fluorocarbon is a mixture of pyromellitate oligomers formed by two reactions, first the reaction of pyromellitic dianhydride with a fluorinated alcohol, second, the reaction product of the first reaction further reacted with epichlorohydrin. The amounts of the fluorocarbon present on the carpet fabric used in the method is an amount

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between about 0.05 and 0.4% by weight of the fabric, the magnesium sulfate can be present in the aqueous solution of the method in an amount between about 0.05 and 0.8% on the weight of the fabric, the ammonium thiocyanate can be present in an amount in about 0.03 to 1% on the weight of the fabric, the sulfonated aromatic condensate can be present in an amount of between about 0.15 and 7.5% on the weight of the fabric, the dialkyl sulfosuccinate can be present in an amount of between 0 and 6 parts by weight to the parts by weight of the sulfonated aromatic condensate and the sodium of the condensed naphthalenic acid can be present in an amount between about 0 and 3 parts by weight to parts by weight of the sulfonated aromatic condensate. The preferred amounts of the compounds are about 0.05 and 0.4% by weight of the fabric of the fluorocarbon, between about 0.08 and 0.4% on the weight of the fabric of the magnesium sulfate, between 0.15 and 0.7% on the weight of the fabric of the ammonium thiocyanate and between about 0.15 and 1.5% on the weight of the fabric of the sulfonated aromatic condensate with the dialkyl sulfosuccinate being present in an amount between 0 and 2.5 parts by weight to the parts by weight of the sulfonated aromatic condensate and the sodium salt of the condensed naphthalenic acid being present in an amount between 0 and 2 parts by weight to parts by weight of the sulfonated aromatic condensate. In order to improve yellowing of the carpet fabric, any of the above aqueous solutions can be buffered with an effective amount of citric acid or any other acid with a sequestering agent. The preferred aqueous solution is buffered with an amount of citric acid between 0.3 and 5.5 grams per liter of aqueous solution.

A two-step process embodiment of this invention uses the aftertreatment process described above but, preceding the initial preheating step of that after-treatment an effective amount of the sulfonated aromatic condensate is added during dyeing of the carpet fabric so that the total of effective amounts of sulfonated aromatic

condensate in both steps is less than the total effective amount useful in either the first dye step, solely, or in the subsequent application step, solely, or so that a more effective degree of stain resistance of the carpet fabric is achieved at the same total of effective amounts of sulfonated aromatic condensate in the two steps as compared to the same amount in either step solely. An effective amount of the salt having a divalent cation can be added during the dyeing so that the s.a.c. exhausts onto the fiber at the possibly higher pH and so that the stain resistance of the nylon fiber in the carpet fabric, especially an easily dyed nylon fiber having a high index of crystalline perfection and having a very open internal crystal polymer structure, is enhanced and durability steam cleaning of the stain resistance is enhanced, or the effective amount of sulfonated aromatic condensate is lower to achieve the same level of stain resistance. The divalent salt again can be calcium, zinc, magnesium or ferrous sulfate, chloride or phosphate. The preferred salt is magnesium sulfate. The preferred amounts of sulfonated aromatic condensate added during dyeing and after dyeing are between about 0.05% on the weight of the fiber to 0.5% on the weight of the fiber during dyeing, an additional 0.05% on the weight of the fiber to 7.5% on the weight of the fiber after dyeing. Also, the preferred amounts of magnesium sulfate are 0.03 to 1% on the weight of the fiber added to the dyebath and 0.05 to 1% on the weight of the fiber added after dyeing. The carpet fabric used in the method can comprise a fluorocarbon present before dyeing. The fluorocarbon again can contain perfluoroalkyl radical or a mixture of fluorinated pyromellitic oligomers. The preferred fluorocarbon is a mixture of pyromellitic oligomers formed by two reactions, first, the reaction of pyromellitic dianhydride with a fluorinated alcohol, and second, the reaction product of the first reaction further reacted with epichlorohydrin. The preceding dyeing step can either be a continuous dyeing operation or it can be batch or beck dyeing. The

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beck dyeing can be done in the presence of an effective amount of a salt having a divalent cation so that the stain resistance of the carpet fabric is enhanced. The preferred amount of magnesium sulfate in the dyebath is an amount between 0.2% on the weight of the fiber to 5% on the weight of the fiber.

Another method to improve stain resistance of nylon or wool fiber comprises treating the fiber with a combination of an effective amount of each of a sulfonated aromatic condensate and a thiocyanate, whereby improved resistance to oxidation to ozone or by other strong oxidizing agents such as benzoyl peroxide is imparted to the s.a.c. and the dye on the fiber. The preferred fiber is carpet fiber, the preferred aromatic condensate is sulfonated aromatic formaldehyde condensate formed by condensation with one or more phenols. At least one of the phenols can be a phenol sulfonic acid or the alkali metal salt thereof. Or at least one of the phenols can be a sulfone. The sulfone can be a dihydroxy aromatic diphenolsulfone. The preferred condensate is formaldehyde condensed with a alkali metal salt of para-phenol sulfonic acid and with 4,4'-diphenolsulfone. This method of improving stain resistance of nylon or wool fiber using a thiocyanate with the sulfonated aromatic condensate can use a thiocyanate selected from the group consisting of ammonium, sodium, potassium, copper, zinc, ferrous, ferric, methyl and phenyl thiocyanate. The most preferred is ammonium thiocyanate. The dispersing agent can be added to the mixture applied to the fiber in this method also. The dispersing agent can be selected from the group consisting of condensed naphthalenic salt, an alkyl sulfosuccinate or a mixture thereof. The preferred dispersing agent is a mixture of the sodium salt of condensed naphthalene sulfonic acid and di-isobutyl sulfosuccinate. The preferred amounts used in this method are between about 0.05 and 10% on weight of the fiber of the sulfonated aromatic condensate, between about 0.1 and 5% on weight of the fiber of the thiocyanate and the

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sodium salt of the condensed naphthalenic sulfonic acid is added in an amount between 0 and 3 parts by weight by parts by weight of the sulfonated aromatic condensate and the di-isobutyl sulfosuccinate is added in amount between 5 0 and 6 parts by weight to the parts by weight of sulfonated aromatic condensate.

Yet another method of improving stain resistance of nylon fiber, particularly fiber having a high index of crystalline perfection, for carpet comprises treating the 10 fiber with a combination of an effective amount each of a sulfonated aromatic condensate, thiocyanate and salt having a divalent cation. The sulfonated aromatic condensate can be a condensate with formaldehyde, can further be formed by the condensation of formaldehyde with 15 one or more phenols and at least one of the phenols can be phenol sulfonic acid and the alkali metal salt thereof or sulfone. The preferred condensate is formaldehyde condensed with a alkali metal salt of para-phenol sulfonic acid and with 4,4'-diphenolsulfone. The preferred 20 thiocyanate is ammonium thiocyanate but the thiocyanate can be ammonium, sodium, potassium, copper, zinc, ferrous, ferric, methyl or phenyl. The preferred salt is magnesium sulfate but the salt can be calcium, magnesium or ferrous chloride, sulfate or phosphate. The fiber treated can 25 comprise an effective amount of the fluorocarbon compound intended to enhance soil resistance of the fiber. The preferred fluorocarbon is a mixture of pyromellitate oligomers formed by two reactions, first the reaction of pyromellitic dianhydride with a fluorinated alcohol and 30 second a reaction product of the first reaction further reacted with epichlorohydrin. A dispersing agent can be added to the combination used to treat the fiber in this method. Dispersing agents can be condensed naphthalenic salt or an alkyl sulfosuccinate or a mixture thereof. The 35 preferred amounts are between 0.15 and 7.5% on weight of the fiber of the sulfonated aromatic condensate between 0.15 and 1% on weight of the fabric of the thiocyanate, between 0.05 and 0.8% on weight of the fabric of the

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divalent cation salt, and between 0.05 and 0.4% on the weight of the fabric of the fluorocarbon present on the fiber before dyeing. As above the condensate and thiocyanate can be buffered with an effective amount of citric acid or any acid with a sequestering agent so light induced yellowing of the stain resistant fiber is reduced.

5 A method of improving light induced yellowing of stain resistant nylon in fiber treated with an effective amount of sulfonated aromatic condensate from an aqueous solution comprises using an effective amount of citric acid or any acid with a sequestering agent to buffer the aqueous solution containing the sulfonated aromatic condensate for treating the fiber at a pH between about 1 and 5.5.

15 Another two-step treatment is a method to dye and treat in two steps (both batch or beck) nylon carpet fabric to impart improved resistance to staining comprising dyeing in a first step in dyed carpet fabric in a dyebath liquor in the presence of an effective amount of a sulfonated aromatic condensate in an aqueous solution at an elevated temperature then removing the dyebath liquor from the dyed carpet fabric then rinsing the dyed carpet fabric then applying in a second step another effective amount of a sulfonated aromatic condensate in an aqueous solution to the dyed carpet fabric at a pH between 1.5 to 20 5.5 at a liquor temperature between 110 and 195°F (60 and 91°C) so that the total of effective amounts of sulfonated aromatic condensate in both steps is less than total effective amount useful in either the first dye steps solely or in a subsequent application step solely or so that a more effective degree of stain resistance of the carpet fabric is achieved at the same total of effective amounts of sulfonated aromatic condensate in said two steps as compared to the same amount in either step solely. The dyeing conditions in the first step are a liquor to fabric ratio of about 10:1 to 100:1 at a temperature of 158 to 212°F (70 to 100°C) for 15 to 90 minutes. Preferred conditions for the second step are a

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liquor to fabric ratio of about 10:1 to 100:1 for a period of about 5 to 60 minutes. The carpet fabric can be also rinsed subsequent to the second step. The sulfonated aromatic condensate can be condensed with formaldehyde.

5 The sulfonated aromatic formaldehyde condensate can be formed by condensation of formaldehyde with one or more phenols. The phenols can be phenol sulfonic acid or the alkali metal salt thereof. Or the phenol can be dihydroxy aromatic diphenol sulfone. The preferred condensate is

10 formaldehyde condensed with alkali metal salt of para-phenol sulfonic acid and with 4,4'-diphenolsulfone. Here again the dyed carpet fabric can comprise an effective amount of a fluorocarbon intended to improve the resistance of soiling of the carpet. The preferred amount

15 of the fluorocarbon is present in an amount of from about 0.05 to 0.4% by weight on weight of the fabric. The fluorocarbon can contain perfluoroalkyl radical or a mixture of fluorinated pyromellitate oligomers. The fluorocarbon can be the reaction product of a

20 perfluoroalkyl alcohol or amide with a suitable anhydride or isocyanate. The fluorocarbon can be the reaction product of N-ethyl perfluorooctylsulfoamideo ethanol with toluene diisocyanate. The preferred fluorocarbon is a mixture of pyromellitate oligomers formed by two

25 reactions, first, the reaction of pyromellitic dianhydride with a fluorinated alcohol, and second, the first reaction product is further reacted with epichlorodrin. The second step aqueous solution can also contain an effective amount of a thiocyanate such as ammonium, sodium, potassium,

30 copper, zinc, ferrous, ferric, methyl or phenyl thiocyanate. The preferred thiocyanate is ammonium thiocyanate. The aqueous solution of either or both application steps can also contain an effective amount of dispersing agent such a condensed naphthalenic salt, an

35 alkyl sulfosuccinate or a mixture thereof. The preferred dispersing agent is a mixture of the sodium salt of condensed naphthalene sulfonic acid and di-isobutyl sulfosuccinate. The aqueous solutions of both steps of

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this invention can also contain an effective amount of salt having divalent cation such calcium, magnesium or ferrous chloride, sulfate or phosphate, preferably magnesium sulfate. The preferred amounts of this method

5 would be having the fluorocarbon present in an amount of 0.05 and 0.4% by weight of the fabric, magnesium sulfate present in an amount of between 0.25 and 4% on the weight of the fabric, ammonium thiocyanate present in an amount between 0.03 and 1% on the weight of the fabric, the

10 sulfonated aromatic formaldehyde condensate present in an amount between 0.15 and 7.5% on the weight of the fabric and the dialkyl sulfosuccinate present in an amount between 0 and 6 parts by parts by weight of the sulfonated aromatic condensate and the sodium salt of a condensed

15 naphthalenic acid is present in an amount between 0 and 3 parts by weight by parts by weight of sulfonated aromatic condensate. The more preferred amounts are where the fluorocarbon is present in an amount of between about 0.05 and 0.4% on the weight of the fabric, the magnesium

20 sulfate is present in an amount between 0.25 and 1.5% on the weight of the fabric, ammonium thiocyanate is present in an amount between 0.05 and 0.75% on the weight of the fabric, sulfonated aromatic formaldehyde condensate is present in an amount between 0.15 and 2.0% on the weight

25 of the fabric and the dialkyl sulfonsuccinate is present in an amount between 0 and 2.5 parts by weight to the parts by weight of the sulfonated aromatic condensate and the sodium salt of a condensed naphthalenic acid is present in an amount between 0 and 2 parts by weight to

30 the parts by weight of the sulfonated aromatic condensate. Here again aqueous solution can be buffered with an effective amount of citric acid or any other acid with a sequestering agent to improve the yellowing of the carpet fabric.

35 Finally, in the last embodiment of this invention a method of improving exhaustion of a water soluble thiocyanate onto polyamide fiber comprising contacting the fiber with an effective amount of the



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thiocyanate at a pH between about 1 and 5 wherein the fiber has improved resistance to fading of dye, due to strong oxidizing agents such as benzoyl peroxide or ozone, the dye being present in or on the fiber, is disclosed.

5 The thiocyanate can be ammonium, sodium, potassium, copper, zinc, ferrous, ferric, methyl or phenyl thiocyanate. The preferred pH of the method is between 1 and 4. The preferred amount of thiocyanate is between about 0.1 and 6% on the weight of the fiber of the  
10 thiocyanate, present in or on the fiber after dyeing. The method improves exhaustion so that between about 0.1 and about 12% on the weight of the fiber of the thiocyanate is present during the contacting and at least 50% of the thiocyanate present during the contacting is exhausted  
15 onto or into the fiber. The preferred thiocyanate is ammonium thiocyanate. The thiocyanate can be contacted with the fiber in the dyebath or after dyeing of the fiber. The fiber being treated can comprise an effective amount of a fluorocarbon to inhibit soiling of the fiber  
20 and a sulfonated aromatic condensate can be present either on the fiber or with the thiocyanate. The various fluorocarbons are as described above. An effective amount of citric acid or any acid with a sequestering agent can also be used to buffer for the condensate and thiocyanate  
25 to the desired pH for this same anti-yellowing effect. It is preferred to have between about 0.1 and 12% thiocyanate on the weight of the fiber and between about 0.05 and 0.4% fluorocarbon on the weight of the fiber.

#### PREFERRED EMBODIMENTS

##### 30 Continuous Aftertreatment Process

This process is intended to continuously treat nylon carpet fabric with sulfonated aromatic condensate formulations, for instance on a continuous dye range after steaming but before washing; or piece (or beck) dyed  
35 carpets may be continuously treated in a similar fashion by treating in-line on the wet goods dryer range prior to the dryer. Equipment could be a spray header(s), or the equivalent, for the heated water across the moving carpet

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5 fabric with vacuum extractors below or a set of squeeze rolls to remove the water, followed by spray headers for the treatment liquor with a catch pan underneath. An alternative to spray application is use of a pressurized applicator, such as a Kusters Fluidyer, which presses the carpet into contact with a narrow slot in a conduit containing treatment liquor under pressure.

10 The prior art describes the application of similar sulfonated aromatic formaldehyde condensates by a beck (piece) aftertreatment and a continuous manner along with dyestuffs and subsequent steaming. The continuous process of this invention has economical advantages over the beck aftertreatment process by approximately 4 cents per pound of fiber produced as finished carpet (at equal  
15 levels of the stain resist agent on the fiber). The continuous aftertreatment process of this invention has the following advantages over the known prior art processes:

20 (a) Post dyeing process. Process conditions are optimized for the "exhaustion" of the sulfonated aromatic formaldehyde condensate onto the fiber. These conditions are not necessarily compatible with the dyeing process. Since the treatment process occurs after dyeing, there is no interference with the dyeing process. Prior art  
25 concurrent (with dyes) processes generally result in poorer dyeing quality, a loss in dye yield and an effect of the dyed shade of the carpet.

30 (b) More versatile. The process of this invention is applicable to both continuously dyed solid or multi-color patterns with the same process conditions. Furthermore, the process is also applicable to continuously aftertreating piece (or beck) dyed goods at the wet goods dryer.

35 The process involves the general principle of first, preheating the carpet with heated water followed by hydroextraction and the application of an aqueous solution of the sulfonated aromatic formaldehyde condensate, for which there are specific ranges of pH, concentration, wet

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pick-up (w.p.u.) and temperatures. This is followed by a dwell period at which the carpet is either held at temperature or is allowed to radiant cool prior to washing the carpet. Prior to the treatment, the carpet has  
5 already been dyed by either beck or continuous methods. For beck-dyed carpets the treatment process is at the wet goods dryer and for continuously-dyed carpets the treatment process is in-line after steaming and prior to the final washing step.

10 The process, in more detail, involves preheating the dyed carpet with hot water followed by hydroextraction by either squeeze or vacuum methods to a wet pick-up of 30 to 190%. The conditions of the preheating process are established to achieve a carpet temperature of 130 to  
15 210°F (54.4 to 99°C) prior to the treatment stage. The conditions of the preheating process are generally using 200% w.p.u. to total saturation with water at 140 to 212°F (60 to 100°C). As an addition in the continuous dyeing process, this also gives the carpet a washing prior to  
20 application of the treatment solution which aids the carpet's receptiveness to the stain resist agent. The treatment solution is an aqueous solution of the sulfonated aromatic condensate at a 0.25 to 40 grams per liter concentration and a pH of 1.5 to 5.5. The treatment  
25 solution is applied at 200 to 600% w.p.u. add-on and a temperature of 140 to 212°F (60 to 100°C). The resulting temperature of the carpet must be in the 130 to 210°F (54.4 to 99°C) range for the treatment to be effective. It is preferred to keep the difference in carpet fabric  
30 temperature between pretreating and application to a minimum. Following the application of the treatment liquor, it is necessary to either maintain the carpet at the application temperature for at least 0.5 to 30 seconds or allow it to radiantly cool to no less than 130°F  
35 (54.4°C).

The equipment used for the application of the treatment liquor may be either spray or contact (e.g. Kusters Fluidyer) in nature. The contact method is

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preferred since it is easier to achieve 100% penetration of the treatment. Spray processes are adequate provided that the solution penetrates to the back of the carpet, and will generally require additional mechanical  
5 considerations, such a squeeze or "S" rollers to achieve complete penetration. Other application equipment may also be used as long as the process requirements of preheating, heated treatment and dwell time at temperature are satisfied. The preheating and/or extracting steps of  
10 this invention may be carried out on the previously existing equipment.

The practical significance of this invention is that it provides an economical and effective means to apply sulfonated aromatic formaldehyde condensates to  
15 impart stain resistance to dyed carpets. The process is applicable to over 90% of all carpets treated with sulfonated aromatic formaldehyde condensates.

The continuous aftertreatment embodiment can also be the second step of another two-step process  
20 embodiment of this invention wherein an effective amount of the sulfonated aromatic condensate is added to a continuous dyebath or in batch or beck process for dyeing carpet fabric. The two-step process uses less overall amount sulfonated aromatic condensate for the same effect  
25 level of stain resistance. Alternatively, the same total amount of sulfonated aromatic condensate can be used in the two-step process to achieve a higher level of stain resistance.

Certain nylon substrates (fiber) have very open  
30 internal structure (orientation of the polymer chains) which require very high amounts of the sulfonated aromatic condensate composition to impart a marketable degree of stain resistance. Certain sulfonated aromatic condensate compositions cannot achieve a sufficient level of  
35 protection on these substrates, so they must be excluded. Also, the continuous aftertreatment method results in only moderate durability of the stain resistance properties to steam cleaning when a high pH detergent is used.

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The two-step application process has all of the advantages of the continuous aftertreatment process such as economics, etc. over one-step batch processes. It also has unique advantages over the aftertreatment process alone and all other known continuous application processes for sulfonated aromatic condensates, such as using all of the sulfonated aromatic condensate in dyebath (currently being practiced on a commercial scale).

The level of stain resistance imparted by a given total amount of the sulfonated aromatic condensate is substantially improved. The required add-on for a marketable level of stain resistance reduced by approximately 30% over aftertreatment and greater for other continuous processes, providing economical advantages. The process (with optimized sulfonated aromatic condensate composition for aftertreatment) yields marketable levels of stain resistance on critical substrates described above using reasonable levels of the sulfonated aromatic condensate composition. The durability of the stain resistance properties to steam cleaning (with and without a high pH detergent) is improved over the aftertreatment only process, yielding improved properties.

The two-step process involves the general principle of applying a portion of the total sulfonated aromatic condensate composition to be applied in the standard dyebath with an appropriate amount of magnesium sulfate (magnesium sulfate, 0 to 0.35% on the weight of the fabric for each 1% on the weight of the fabric of the sulfonated aromatic condensate). The balance of the total sulfonated aromatic condensate composition (with 0 to 0.35% of magnesium sulfate) is then applied as an aftertreatment. The amount of Epsom Salt required in both portions depends on the sulfonated aromatic condensate and the substrate being treated.

The dyebath composition is based on that typically used for continuous dyeing. The appropriate amount of the sulfonated aromatic condensate composition

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(based on the optimum ratio and the total required for the particular substrate) is added to the dyebath.

More specific examples of the processes are given in the following Examples.

5 Preferred Treatment Compositions

In addition to a sulfonated aromatic condensate other chemical compounds such as a thiocyanate are added to the formulation used to treat the carpet fabric to overcome oxidative yellowing of the sulfonated aromatic  
10 condensate, and to provide the resulting carpet with better resistance of the dyes to strong oxidizing agents, such as ozone or the benzoyl peroxide found in commercial anti-acne preparations. Also a salt containing a divalent cation is useful to improve exhaustion of the sulfonated  
15 aromatic condensate on high ICP polymer fibers. A dispersing agent(s) is usually necessary in the formulation to prevent precipitation or coagulation due to incompatibility of the components of the formulation for treatment and/or the components with a fluorocarbon  
20 treated carpet fabric. Acids are used to buffer the formulations. It has been discovered that citric acid or any acid with a sequestering agent creates an additional improvement in yellowing characteristics of sulfonated aromatic condensate treated fiber or fabric.

25 Ammonium thiocyanate and sulfonated aromatic condensates exhaust onto nylon fibers under comparable application procedures. The two products may be co-applied providing that the uptake of one material does not interfere with the other. Therefore, the selection of  
30 the sulfonated aromatic condensate is important. Some sulfonated aromatic condensates exhaust preferentially over ammonium thiocyanate. But to the contrary there was a synergistic effect of Intratex N (which is reported to be formaldehyde condensed with an alkali metal salt of  
35 para-phenol sulfonic acid and with 4,4'-diphenolsulfone) and ammonium thiocyanate on benzoyl peroxide spotting resistance.

An additional benefit of ammonium thiocyanate in

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the composition is as an antioxidant to prevent light induced yellowing of Intratex N. This combination was found to give a sufficient improvement (acceptable light-fastness) for beck applications, but was insufficient for continuous applications (although improved).

The combination of sequestering agents, such as EDTA and sodium hexametaphosphate, with Intratex N was found to result in some improvement in light induced yellowing, but did not yield completely acceptable results for the continuous application. Combination of Intratex N with citric acid (sequestering and antioxidant properties) also gave similar results. The combination of ammonium thiocyanate and citric acid was discovered to achieve the best results in the reduction of light induced yellowing for continuous application, showing virtually no yellowing. (Combinations of ammonium thiocyanate and other sequestering agents were not as effective.)

A novel dispersant system, using Tamol SN and Monawet MB-45 was developed to prepare a stable composition containing Intratex N, ammonium thiocyanate and citric acid in concentrated form for continuous applications. A new dispersant system was developed to prepare a stable concentrate containing Intratex N and ammonium thiocyanate for beck applications.

#### 25 Example Compositions:

Component	Composition Solids,		Composition Solids,	
	1, %	%	2, %	%
Intratex N* (s.a.c.)	-	-	18.9	3.8
30 Intratex N-1*	25	5	-	-
Ammonium Thiocyanate	6.00	6	-	-
Citric Acid (50% solution)	14.30	7.15	-	-
Sulfuric Acid	-	-	1.11	1.1
35 Tamol SN (sodium salt of condensed naphthalene sulfonic acid)	4.00	3.9	7.32	7.1

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Example Compositions: (Continued)

Component	Composition Solids,		Composition Solids,	
	1, %	%	2, %	%
5 Monawet MB-45 (di-isobutyl sulfosuccinate)	20.00	9	-	-
Epsom Salt	6.00	6	-	-
(Magnesium Sulfate)	24.7	2.9		
Demineralized Water	33.03	0	72.65	0
10 * Same concentration of same s.a.c., N-1 has pH 7, N has pH 10.5.				

Any thiocyanate such as those listed in the Summary of the Invention is expected to be effective, although the copper, ferrous and ferric thiocyanates may have to be color compensated.

As dispersing agents any agent that is effective can be used, such as for any process formulation, the condensed naphthalenic salts, the alkyl sulfosuccinates, a mixture of them, and for batch process systems salts of polymeric carboxylic acid, and polyethylene glycol ethers.

As sequestering agents, the polyphosphates, such as sodium tripolyphosphate (STPP), aminocarboxylic acids, such as ethylenediamine tetraacetic acid (EDTA), hydroxycarboxylic acids, such as tartaric and citric acid, and the aminoalcohols, such as triethanolamine (TEA) are expected to be effective. See Kirk-Othmer Encyclopedia of Chemical Technology, supra.

Example 1

On a commercial dyeing range Composition 1 was applied both in a two-step (continuous-continuous) and in a continuous aftertreatment only process to a normal and to a high ICP fiber carpet fabric. The normal fiber was in an 1186 denier Superba heat set textured yarn. The high ICP fiber was a 1700 denier textured yarn which was heat set by a proprietary Pharr process with a high heat history giving an ICP of 3.92 compared to normal ICP of about 3.8. Both fibers were previously treated with a



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spin finish containing a soil-release fluorocarbon as described in U.S. 4,604,316 and/or U.S. 4,192,754. The fabric was dyed gray. The prewash and treatment application was by spray just after the dryer but before the final wash on the continuous dye range. Following are the dyes and chemicals used in the continuous dyebath.

Control:

0.135 g/l\*\* Nylanthrene<sup>1</sup> Orange RAR (liquid)  
0.092 g/l Tectilon<sup>2</sup> Red 2B Liq.-50  
10 0.052 g/l Telon<sup>3</sup> Blue B-AR (powder)  
(the above dyes are the same for all dyebaths.)  
3.0 g/l Alrowet<sup>2</sup> D-70 \*  
1.0 g/l Chemcogen<sup>4</sup> DCG \*  
0.5 g/l Defoamer AC (Fuller) \*  
15 pH 5.5 with Acetic Acid  
400% w.p.u. via Kuster Fluidyer  
Steam in vertical steamer 5 to 6 minutes

"4% Dyebath":

(Order of addition to bath as listed.)  
20 3.0 g/l Alrowet D-70  
1.0 g/l Chemcogen DCG  
0.5 g/l Defoamer AC (Fuller)  
10.0 g/l Composition 1  
1.25 g/l Epsom Salt (Magnesium Sulfate)  
25 0.5 g/l Sequestrene<sup>2</sup> 30A \*  
Dyes above  
Approximately 1 g/l Ammonia to pH 5.5

"8% Dyebath":

(Order of addition to bath as listed.)  
30 3.0 g/l Alrowet D-70  
1.0 g/l Chemcogen DCG  
0.5 g/l Defoamer AC (Fuller)  
20.0 g/l Composition 1  
2.5 g/l Epsom Salt (Magnesium Sulfate)  
35 0.5 g/l Sequestrene 30A \*  
Dyes above  
Approximately 3 g/l Ammonia to pH 5.5

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\* Alrowet D-70 is dioctyl sulfosuccinate - 70% active  
Chemcogen DCG is sulfonated alkyl diphenylether -  
30-38% active.

Defoamer AC is a proprietary defoamer from Fuller Sales.

5 Sequestrene 30A is ethylene diamine tetraacetic acid.

1 " of Crompton & Knowles

2 " of Ciba Geigy

3 " of Mobay

10 4 " of Lyndal Chem.

\*\* grams per liter

The following tables provide other operating  
conditions and results, using the above dyebaths and the  
shown aftertreatments. Trials 3 and 4 were omitted  
15 because they had a slightly different, nonpreferred,  
formulation.

TABLE I

Aftertreatment (A/T) Application Data

	Trial I.D.*	Nominal Comp.1 Add-on from Dyebath, % owf	Nominal Comp.1 Add-on from A/T, % owf	Total Nominal Comp.1 Add-on, % owf	Preheat Liquor Temperature, °F (°C)	
20	1	0	0	0	142	(61.1)
	5	0	11.0	11.0	140	(60.0)
	9	4.0	7.0	11.0	141	(60.6)
	10	4.0	11.0	15.0	140	(60.0)
	2	0	0	0	142	(61.1)
30	6	0	10.9	10.9	140	(60.0)
	8	4.0	7.0	11.0	141	(60.6)
	7	0	14.9	14.9	140	(60.0)
	11	4.0	10.9	14.9	140	(60.0)
	12	8.0	7.0	15.0	140	(60.0)
35	13	8.0	11.0	19.0	140	(60.0)

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TABLE I (CONTINUED)

Aftertreatment (A/T) Application Data

5	Trial I.D.*	Carpet Temperature Before A/T,		A/T Liquor, pH	Post-A/T Carpet Temperature,	
		°F	(°C)		°F	(°C)
	1	128	(53.3)	7.6	157-159	(69.4-70.6)
	5	127-129	(52.8-53.9)	2.9	155-156	(68.3-68.9)
	9	129-130	(53.9-54.4)	3.0	158-159	(70.0-70.6)
10	10	128-129	(53.3-53.9)	2.9	155-157	(68.3-69.4)
	2	128	(53.3)	7.6	156-158	(68.9-70.0)
	6	127-129	(52.8-53.9)	2.9	158-160	(70.0-71.1)
	8	128-131	(53.3-55.0)	3.0	158-159	(70.0-70.6)
	7	128-129	(53.3-53.9)	2.8	160-162	(71.1-72.2)
15	11	129-131	(53.9-55.0)	2.9	157-158	(69.4-70.0)
	12	129-130	(53.9-54.4)	3.0	160-161	(71.1-71.7)
	13	130	(54.4)	2.9	157-159	(69.4-70.6)

\* Numbers 1, 5, 9 and 10 trials are normal carpet fabric; remaining numbers are high ICP carpet fabric. Trials

20 1 and 2 are a controls.

Both fabrics are 40 oz/sq yd cut piles.

A/T Liquor Temperature ranged from 180-182°F (82.2-83.3°C).

TABLE II

SOLUTION AND CARPET ANALYSIS DATA

25	Trial I.D.	Concurrent Portion (in Dyebath)			
		Target Nominal Comp.1 Add-on, % owf	Nominal Comp.1 Conc.in Dyebath, g/l	Anal. Comp.1 Conc.in Dyebath, g/l	Calc. Comp.1 Add-on from Analysis, % owf
	1	0	0	0	0
	2	0	0	0	0
	5	0	0	0	0
30	6	0	0	0	0
	7	0	0	0	0
	8	4.0	10.0	9.2	3.7
	9	4.0	10.0	9.2	3.7
	10	4.0	10.0	9.2	3.7
40	11	4.0	10.0	9.3	3.7
	12	8.0	20.0	16.8	6.7
	13	8.0	20.0	16.8	6.7

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TABLE II (CONTINUED)  
SOLUTION AND CARPET ANALYSIS DATA

		<u>Aftertreatment Portion</u>			
5	<u>Trial I.D.</u>	<u>Target Nominal Add-on, % owf</u>	<u>Conc. Deliv., GPM*</u>	<u>Actual A/T</u>	<u>Total A/T Liquor Deliv., GPM*</u>
				<u>Spray Header Pres., psig</u>	
	1	0	0	6.7	77
10	2	0	0	6.6	76
	5	11.2	1.19	6.5	75
	6	11.2	1.19	6.6	76
	7	15.2	1.62	6.6	76
	8	7.2	0.76	6.6	76
15	9	7.2	0.76	6.6	76
	10	11.2	1.19	6.7	77
	11	11.2	1.19	6.7	76
	12	7.2	0.76	6.6	76
	13	11.2	1.19	6.5	75

20 Line speed for both fabrics was 30 ft/min.

Throughput = 99.8 lb carpet/min.

Actual dyeing wet pick-up was 400% in all cases.

Aftertreatment wet pick-up was always between 626 and 643%.

25 Aftertreatment pH was always between 2.8 and 3.0 except control was 7.6.

\* gallons per minute

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TABLE II (CONTINUED)

SOLUTION AND CARPET ANALYSIS DATA

		<u>Aftertreatment Portion</u>			
		Calc.	Anal.	Calc.	Calc.
		Nominal	A/T	Comp.1	Comp.1
	Trial	A/T	A/T	Add-on	Add-on
		Liquor	Liquor	from	from
	<u>I.D.</u>	<u>Conc.,</u>	<u>Conc.,</u>	<u>Set-up,</u>	<u>Analysis,</u>
		<u>g/l</u>	<u>g/l</u>	<u>% owf</u>	<u>% owf</u>
5	10	1	0	0	0
		2	0	0	0
		5	17.4	14.8	11.0
		6	17.2	14.8	10.9
		7	23.3	22.4	14.9
15		8	11.0	11.6	7.0
		9	11.0	11.6	7.0
		10	17.0	18.4	11.0
		11	17.2	18.4	10.9
		12	11.0	11.2	7.0
20	13	17.4	13.6	11.0	8.6

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TABLE II (CONTINUED)  
SOLUTION AND CARPET ANALYSIS DATA

		Concurrent and Aftertreatment Portion				
5	Trial I.D.	Target Comp.1 Add-on, % owf	Calc. Comp.1 Add-on from Set-up, % owf	Calc. Comp.1 Add-on from ANALYSIS, % owf	Anal. Comp.1 Add-on from Carpets, % owf	Anal. s.a.c. Add-on from Carpets, % owf
10	1	0	0	0	0	0
	2	0	0	0	0	0
	5	11.2	11.0	9.3	10.6	2.6
	6	11.2	10.9	9.4	10.9	2.7
	7	15.2	14.9	14.3	16.3	4.0
15	8	11.2	11.0	11.1	10.7	2.6
	9	11.2	11.0	11.1	11.1	2.7
	10	15.2	15.0	15.6	14.0	3.5
	11	15.2	14.9	15.4	15.4	3.8
	12	15.2	15.0	13.8	15.8	3.9
20	13	19.2	19.0	15.3	19.6	4.9

Line speed for both fabrics was 30 ft/min.

Throughput = 99.8 lb carpet/min.

Actual dyeing wet pick-up was 400% in all cases.

Aftertreatment wet pick-up was always between 626 and 643%.

25 Aftertreatment pH was always between 2.8 and 3.0 except control was 7.6.

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TABLE III  
STAINING DATA

		Nominal Comp. 1 Add-on from	Nominal Comp. 1 Add-on from	Total Nominal Comp.1 Add-on, % owf			
	Trial I.D.	Dyebath, % owf	A/T, % owf				
	1	0	0	0			
	5	0	11.0	11.0			
10	9	4.0	7.0	11.0			
	10	4.0	11.0	15.0			
	2	0	0	0			
	6	0	10.9	10.9			
	8	4.0	7.0	11.0			
15	7	0	14.9	14.9			
	11	4.0	10.9	14.9			
	12	8.0	7.0	15.0			
	13	8.0	11.0	19.0			
		Stain Rating <sup>1</sup> (0=best 10=worst)					
20	Trial I.D.	Time Before Blotting with Water, Hours					
		1	4	7	24	4	24
		Originals				After	s.c.*
	1	8.5	8.5	8.5	8.5	8.5	8.5
	5	0.25	0.25	0.25	0.25	4.5	5.0
25	9	0	0	0	0	3.5	4.5
	10	0	0	0	0	3.0	4.0
	2	9.0	9.0	9.0	9.0	8.0	8.5
	6	2.5	2.5	2.5	2.5	4.5	5.5
	8	0.1	0.5	0.1	0.25	2.5	4.0
30	7	0.25	1.5	1.5	1.5	5.0	6.0
	11	0	0.1	0.1	0.25	3.0	4.0
	12	0	0	0	0.1	1.0	2.0
	13	0	0	0	0	1.0	1.0

\* steam cleaning

35                      2 passes of detergent solution using  
conventional steam cleaning equipment. Detergent  
solution: 1 oz./gal. ALL-IN-ONE (Certified Chemical &  
Equipment, Cleveland, OH).

<sup>1</sup> See Example 6, Part 2, "Performance", "Drop Test".

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TABLE IV

REPELLENCY AND COLORFASTNESS DATA

5	Trial I.D.	Comp. 1 Add-on from Dyebath; % owf	Comp. 1 Add-on from A/T, % owf	Total Nominal Comp. 1. Add-on, % owf	Repellency <sup>3</sup>	
					Oil	Water
	1	0	0	0	5.0	4.0
	5	0	11.0	11.0	5.0	4.0
	9	4.0	7.0	11.0	4.0	4.0
10	10	4.0	11.0	15.0	4.5	3.5
	2	0	0	0	5.0	5.0
	6	0	10.9	10.9	5.0	4.0
	8	4.0	7.0	11.0	5.0	5.0
	7	0	14.9	14.9	5.0	4.0
15	11	4.0	10.9	14.9	4.0	4.0
	12	8.0	7.0	15.0	4.0	4.0
	13	8.0	11.0	19.0	4.0	3.5

20

Grey Scale Rating

	Trial I.D.	Lightfastness		Ozonefastness <sup>1</sup>			NO <sub>2</sub> <sup>2</sup> Fastness
		20 AFU*	40 AFU	1 cy**	3 cy	5 cy	1 cy**
	1	4.5	4.0	3.0	2.0	1.5	3.0
25	5	4.5	4.0	3.5	3.0	2.5	2.5
	9	4.5	4.0	3.5	3.0	2.5	3.0
	10	4.5	4.0	3.5	3.0	2.5	3.0
	2	4.0	3.5	3.0	2.0	1.5	3.0
	6	4.0	4.0	3.0	2.5	2.5	2.5
30	8	4.5	4.0	3.5	3.0	2.5	3.0
	7	4.0	4.0	3.0	3.0	2.5	2.5
	11	4.0	3.75	3.5	3.0	3.0	3.0
	12	4.0	3.25	3.0	3.0	2.5	2.5
	13	3.5	3.0	3.0	3.0	2.5	2.5

35

\* AATCC 16E fading unit

\*\* cycles

<sup>1</sup> AATCC 129<sup>2</sup> AATCC 164



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3 Oil Repellency

- AATCC TM-118, Oil Repellency: Hydrocarbon  
Resistance Test.

Water Repellency

5 DuPont Isopropanol/water series

1. 2/98 IPA/Water (55)

2. 5/95 IPA/Water (47)

3. 10/90 IPA/Water (40)

4. 20/80 IPA/Water (33)

10 5. 30/70 IPA/Water (28)

Numbers in parentheses represents surface tension of the  
test fluids.

TABLE V

BENZOYL PEROXIDE SPOTTING DATA\*

15

Trial I.D.	Comp. 1 Add-on from Dyebath, % owf	Comp. 1 Add-on from A/T, % owf	Total Nominal Agent Add-on, % owf	Spot Visibility 0=Invisible; 10=Bright Benzoyl Peroxide Conc., % Soln. in Acetone				
				.01	.05	.10	1.0	5.0
20	1	0	0	6.5	7.0	8.0	9.0	9.0
	5	0	11.0	0	1.0	2.0	4.5	5.5
	9	4.0	7.0	0	1.0	2.0	5.5	6.0
	10	4.0	11.0	0	2.0	2.0	5.5	6.0
25	2	0	0	5.0	6.5	6.5	9.0	9.0
	6	0	10.9	0	1.0	1.5	5.0	6.0
	8	4.0	7.0	0	1.0	2.0	6.0	6.5
	7	0	14.9	0	0.5	1.0	4.5	6.0
	11	4.0	10.9	0	1.0	2.0	5.0	5.5
30	12	8.0	7.0	0	0.5	1.5	4.5	5.5
	13	8.0	11.0	0	0.5	1.5	5.0	5.5

\* Sample spotted with 1-ml of benzoyl peroxide solution  
and exposed in chamber at 90°F (32.2°C) and 80% R.H.

35 for three days (color change ceases).

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TABLE VI  
SOILING DATA

					Soil Rating (0=best, 10=worst)			
5	Trial I.D.	Comp.1 Add-on from Dyebath, % owf	Comp.1 Add-on from A/T, % owf	Total Nominal Comp.1 Add-on, % owf	Treads			Total Soil Rating
					Accl.* Method	JTCC**		
						5K	5K	
10	1	0	0	0	5.0	5.5	7.0	17.5
	4	0	10.9	10.9	5.5	6.0	7.0	18.5
	5	0	11.0	11.0	5.5	6.0	7.5	19.0
	9	4.0	7.0	11.0	4.5	6.0	7.5	18.0
	10	4.0	11.0	15.0	4.5	6.0	7.5	18.0
15	2	0	0	0	5.5	4.0	5.5	15.0
	3	0	10.9	10.9	5.5	4.5	6.0	16.0
	6	0	10.9	10.9	5.5	5.5	6.5	17.5
	8	4.0	7.0	11.0	4.0	5.0	7.0	16.0
	7	0	14.9	14.9	5.5	5.5	7.0	18.0
20	11	4.0	10.9	14.9	4.0	4.5	7.0	15.5
	12	8.0	7.0	15.0	4.5	5.5	7.0	17.0
	13	8.0	11.0	19.0	4.5	5.5	7.0	17.0

\* Accelerated soiling conducted at Petersburg Rehabilitation Center using "natural soil" with 2.5% mineral oil added.

\*\* John Tyler Community College Maintenance Hall.

Example 1 - Conclusions

The two-step process with composition gives considerably better stain resistance than the aftertreatment (only) process, at equal total add-on levels. This shows potential for achieving acceptable performance at lower total add-on levels.

The two-step process also gives acceptable stain resistance on the "high ICP" substrate at levels comparable to that currently being used for s.a.c. normal substrates by aftertreatment only.

Stain resistnace improves and lightfastness is adversely effected (yellowing) as the Composition 1 concentration in the concurrent portion increases, with total add-on level constant. Acceptable yellowing and stain resistance was achieved at 4% on the weight of the fiber of Composition 1 in the concurrent portion.

"Optimum" two-step systems had improved ozone and benzoyl peroxide (B.P.) spotting resistance properties. Some reduction does occur as the concentration applied by the aftertreatment portion is reduced in favor of the concurrent portion.

Example 1 - Summary of ResultsStaining Performance Table III:

In general, the standard Superba heat set (H/S) substrate performed beter than the high ICP substrate at equivalent application conditions, while analyzed add-on's were equal. This is normally observed because of undesired deep penetration of s.a.c. into fiber of high ICP.

When applied by aftertreatment only, Composition 1 on the high ICP fabric did not yield acceptable staining performance. When the level of Composition 1 was increased from 11 to 15% owf on the high ICP fabric, stain resistance was further improved to a "Marginal" performance level (stain rating of 1.5 at 4- and 24-hour blot times).

The two-step process gave considerably better stain resistance than the aftertreatment only process on both substrates, at equal total application levels. No

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staining at 24 hours was obtained on the Superba H/S fabric using 4% on the weight of the fiber in the Dyebath and 7% on the weight of the fiber in the A/T. These same levels on the high ICP substrate gave staining performance equal to the Superba fabric aftertreated (only) with 11% on the weight of the fiber of Composition 1 (stain rating of 0.5 at 24 hours).

#### Example 1 - Summary of Results

##### Colorfastness Table IV:

10 No light induced yellowing was observed at 20 AFU on any of the trials conducted, but began to be noticed at 40 AFU.

Light induced yellowing (at 40 AFU) became more noticeable as the amount in the concurrent portion was increased (and aftertreatment was reduced). Trials with 15 8% on the weight of the fiber Composition 1 in the concurrent portion (high ICP substrate) were marginal to unacceptable for lightfastness.

The improvement in resistance to ozone fading, 20 obtained with Composition 1 by aftertreatment was also observed with Composition 1 and also using the two-step process with Composition 1 (at lower level).

##### Benzoyl Peroxide Spotting Table V:

The two-step process gave only a slight 25 reduction in the benzoyl peroxide spotting performance than the aftertreatment process, at equal add-on levels.

##### Repellency Table IV:

There was no significant effect in any of the trials on oil and water repellency. As the amount of 30 Composition 1 (and magnesium sulfate) in the concurrent portion was increased, the oil repellency tended to decrease slightly.

##### Soiling Table VI:

Only a slight negative effect in soiling was 35 observed on all trial samples compared to the control.

Composition 1 showed slightly more soiling when applied by aftertreatment, as the concentration applied was increased.

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With total add-on constant, the two-step process had less impact on soiling than aftertreatment alone.

Two-Step Process Guidelines (Best Mode)  
For The Continuous Application of Composition 1

5 Concurrent (with dyestuffs) Portion:

For Suessen H/S Substrates:	2.0% owf
For Superba H/S Substrates:	3.0% owf
For "High ICP" Substrates:	4.0-5.0% owf

Dyebath Make-up Procedure:

10 1st - Wetting and leveling agents (defoamer, if required)

2nd - Composition and Epsom Salt\*\* ( $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ )  
(0.5% owf Epsom Salt for each 4.0% owf Composition 1)

3rd - 0.25-0.50 g/l Sequestering agent (EDTA)

15 4th - Dyestuffs

5th - Adjust to desired pH with either acetic acid, ammonia or caustic soda\*

Notes:

20 \* Composition 1 has low pH. Use in the dyebath will result in pH's of 3.0-3.5, requiring an alkali to adjust pH.

\*\* Only phosphates which form water-soluble complexes with magnesium ion may be used in the presence of magnesium sulfate.

25 Aftertreatment Portion:

Composition 1 Concentration:

For Suessen H/S Substrates:	3.0% owf
For Superba H/S Substrates:	5.0% owf
For "High ICP" Substrates:	7.0 -8.0%

30 Application Parameters:

Preheat/wash spray at 160°F (71.1°C) and extract (vacuum) to 75-125% w.p.u. to give carpet temperature of 140°F (60°C).

35 Apply treatment solution at 180°F (81.2°C) and 400-500% w.p.u. to give a post-A/T carpet temperature of 160°F (71.1°C).

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Example 2

This is a further example of the continuous aftertreatment process of the invention, using Composition 2 in the treatment of the carpet fabric. The fabrics treated were (a) a fabric tufted from an 1186 denier continuous filament textured medium dye fiber in a Superba heatset (H/S) yarn to a 28-ounce cut pile fabric and (b) a textured 3.15/2 cotton count yarn from a 19 denier per filament staple deep dye fiber heat in a Suessen and tufted into 48-ounce fabric. Both were pretreated with the fluorocarbon of Example 1 and were to be dyed light gray. The nominal application conditions were 140°F (60°C) preheat water temperature, 180°F (81.2°C) application liquor temperature, 500 to 600% w.p.u. application liquor, the dyes and dyebath additives were as in Example 1, except no sequestrene was used. No Composition 2 or other s.a.c. was added to the dyebath. The following Tables show the application conditions and results.

TABLE VII  
APPLICATION DATA

Trial I.D.	Nominal Comp.2 Applied, %	Target Nominal s.a.c. Level, % owf	Target Nominal Epsom Salts Level, % owf	Actual A/T		Target A/T Liquor
				Header	A/T Liquor	
				Pres., psig	Deliv., GPM	Conc., g/l
1	0	0	0	6.2	73.3	0
2	15.0	2.8	0	6.2	73.3	25.0
3	0	0	0	6.5	75.2	0
4	9.0	1.7	0	6.5	75.2	17.2

Actual w.p.u. was between 523 and 532%, pH was 8.3 for control; 3.0 for Trial 2; 3.3 for Trial 4.

Preheat liquor temperature was 140°F (60°C). Carpet temperature was 127-130°F (52.8-54.4°C). Application liquor temperature was 179-182°F (81.7-83.5°C) and carpet temperature was 156-161°F (68.9-71.7°C).

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TABLE VII (CONTINUED)

APPLICATION DATA

5	Trial I.D.	Calc.s.a.c.						
		Calc. Conc. Comp.2 Liquor g/l	Anal. Conc. Comp.2 Liquor g/l	Calc. Add-on from Set-up % owf	Calc. Add-on from Set-up % owf	Calc. Add-on from A/T Liquor % owf	Anal. Add-on from Carpets % owf	Calc. Epsom Salt Add-on % owf
10	1	0	0	0	0	0	0	0
	2	30.4	21.2	17.7	3.4	2.3	2.62	0
	3	0	0	0	0	0	0	0
	4	20.9	14.4	10.9	2.1	1.5	1.89	0

Actual w.p.u. was between 523 and 532%, pH was 8.3 for control; 3.0 for Trial 2; 3.3 for Trial 4.

Preheat liquor temperature was 140°F (60°C). Carpet temperature was 127-130°F (52.8-54.4°C). Application liquor temperature was 179-182°F (81.2-83.3°C) and carpet temperature was 156-161°F (68.9-71.7°C).

20

TABLE VIII

STAINING PERFORMANCE, DURABILITY TO STEAM CLEANING AND CHANGE-OF-SHADE DATA

25	Sample I.D.	Nominal Comp.2 Applied, %	Stain Rating (0=best, 10=worst) — Time Before Blotting with Water, Hr			
			0.05	0.5	1	4
30	1	0	8.5	8.5	8.5	8.5
	2	15	0.25	0.25	0.75	1.5
	3	0	4.5	7.0	7.0	7.0
	4	9	0	0	0	0.1

35	Sample I.D.	Stain Rating (0=best, 10=worst) Time Before Blotting with Water, Hr		S.C.**	Shade Change *
		8	24		
				4	
40	1	8.5	8.5	7.0	-
	2	1.75	2.0	5.0	M-N (Y)
	3	7.0	7.0	7.0	-
	4	0.1	0.1	3.0	M (Y)

\* N=no, acceptable; M=marginal; Y=yellow.

Letter in parentheses indicates direction of color change from the control.

\*\* steam cleaned.

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TABLE IX  
COLORFASTNESS DATA

5	Sample I.D.	Nominal Comp.2 Applied, %	Grey Scale Rating Lightfastness, AFU	
			20	40
	1	0	4.0	3.0
	2	15.0	2.5	3.0
	3	0	4.5	3.5
	4	9.0	3.5	3.5

10

		Grey Scale Rating				NO <sub>2</sub> * Fastness
Sample I.D.		Ozonefastness				1 cy
		1	2	3	5	
15	1	3.0	2.5	2.0	1.0	2.5
	2	3.0	2.5	2.5	2.0	1.0
	3	3.5	3.0	2.5	2.0	2.5
	4	3.5	3.0	3.0	2.5	1.5

20 \* High R.H. nitrogen dioxide (AATCC TM-164).

TABLE X  
BENZOYL PEROXIDE SPOTTING DATA\*

25	Sample I.D.	Nominal Comp.2 Applied, %	Spot Visibility (0=Invisible; 10=Bright)				
			Originals				
			Benzoyl Peroxide Conc., % Solution in Acetone				
			0.01	0.05	0.10	1.0	5.0
30	1	0	2.0	7.5	8.0	9.0	9.5
	2	15	1.0	6.5	7.0	8.5	8.5
	3	0	2.0	7.5	8.0	9.0	9.5
	4	9	2.0	7.5	8.0	8.5	8.5

35 \* Sample spotted with 1 ml of benzoyl peroxide solution and exposed in chamber at 90°F (32.2°C) and 80% R.H. for three days (color change ceases).



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TABLE X (CONTINUED)BENZOYL PEROXIDE SPOTTING DATA\*Spot Visibility (0=Invisible; 10=Bright)  
Steam Cleaned

Sample I.D.	Benzoyl Peroxide Conc., % Solution in Acetone				
	0.01	0.05	0.10	1.0	5.0
1	1.0	5.0	7.0	9.0	9.5
2	0.25	5.0	7.0	8.5	9.0
3	0.5	5.0	7.0	8.5	9.0
4	0.3	4.5	6.5	8.0	9.0

\* Sample spotted with 1 ml of benzoyl peroxide solution and exposed in chamber at 90°F (32.2°C) and 80% R.H. for three days (color change ceases).

TABLE XIREPELLENCY DATA (FINISHED CARPETS)

Sample I.D.	Nominal Comp.2 Applied, %	Repellency	
		Oil	Water
1	0	4.0	4.0
2	15.0	4.0	4.5
3	0	3.0	4.0
4	9.0	3.0	4.5

This Example 2 demonstrates the effectiveness of the sulfonated aromatic condensate with only a dispersing agent and further demonstrates the effectiveness of the continuous aftertreatment process of this invention.

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Example 3 - Part 1

This example demonstrates the effective use of the process of this invention on fabric which has not been previously treated with any fluorocarbon compound for antisoiling properties. The Composition 2 used in the continuous aftertreatment process (no two step) of this invention as set forth in Example 1. Dyebath formulation was as in Example 2. Conditions were as in Example 1, more specifically, preheat water temperature was 195°F (90.6°C) at 100% w.p.u. to achieve carpet temperature of 135-140°F (57.2 to 60°C). Aftertreatment liquor temperature was 180-185°F (82.2 to 85°C) to achieve carpet temperature of 160-170°F (71.1 to 76.7°C). Aftertreatment dwell time was 30 seconds before washing at 40:1 liquor to fabric ratio, hydroextraction and drying. Both compositions were applied at both 1.5 and 3.0% on the weight of the fabric. Samples of fabric pretreated with fluorocarbons, which are also part of the invention, were run alongside the fabric untreated with fluorocarbon. The results show that higher amounts of sulfonated aromatic condensate must be applied to the fabric untreated with fluorocarbon to achieve the nearly same level of stain resistance. The following tables give application conditions and results.

TABLE XII

EVALUATION OF STAIN BLOCKING FOR  
CONTINUOUS AFTERTREATMENT

Sample I.D.	Nominal Add-on, % *	Stain Rating Total <sup>1</sup>		20 AFU Rank <sup>2</sup>	
		Fabric With Fluoro.	Fabric Without Fluoro.	Fabric With Fluoro.	Fabric Without Fluoro.
1	0	54.0	45.0	2	3
2	3.0	1.5	1.4	4	7
3	3.0	0.3	0.3	4	9
4	3.0	1.2	1.5	4	9

\* Samples 2 and 4 applied at pH 3. Samples 1 and 3 were applied at pH 2.

<sup>1</sup> Total of ratings at 1, 4, 7 and 24-hour tests. High numbers indicate most stain.

<sup>2</sup> Lower numbers are better.

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TABLE XII (CONTINUED)  
EVALUATION OF STAIN BLOCKING FOR  
CONTINUOUS AFTERTREATMENT

Sample I.D.	<u>NO<sub>2</sub> Rank<sup>2</sup></u>		<u>Soiling Rating**</u>	
	<u>Fabric With Fluoro.</u>	<u>Fabric Without Fluoro.</u>	<u>Fabric With Fluoro.</u>	<u>Fabric Without Fluoro.</u>
1	1	1	4	8
2	2	2	9.5	9
3	2	3	10	10
4	2	2	5.5	7.5

\*\* Soiling evaluated under Accelerated Method, 0=best,  
 10=worst.

<sup>2</sup> Lower numbers are better.

TABLE XIII  
ANALYSIS DATA

Sample I.D.	Nominal Add-on, %	<u>S.a.c. Analyzed, % owf*</u>	
		<u>Fabric With Fluoro.</u>	<u>Fabric Without Fluoro.</u>
1	-	0	0
2	3.0	3.09	2.96
3	3.0	3.47	3.36
4	3.0	2.94	2.86

Samples 2 and 4 were applied at pH 3. Samples 1 and 3  
 were applied at pH 2.

\* Extracted from carpets with 0.1N NaOH for four hours and  
 analyzed by HPLC against original material.

Example 3 - Part 2

The conditions of Example 3 - Part 1 were  
 repeated except Composition 1 was used with the results  
 shown in the following tables. All fabric was without  
 fluorocarbon treatments.

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TABLE XIV

STAINING AND CHANGE-OF-SHADE DATA

5	Trial I.D.	Nominal Comp.1 Add-on, % owf	Stain Rating (0=best,10=worst)				Shade Change
			Time Before Blotting				
			With Water, Hr				
			1	4	7	24	
	1	-	7.0	7.0	7.0	7.0	-
	2	5.0	0.25	1.0	1.0	0.75	M (Y)
10	3	6.0	0.1	0.75	0.75	0.5	M (Y)
	4	7.0	0.1	0.25	0.25	0.25	M (Y)
	5	8.0	0.1	0.25	0.25	0.25	M (Y)

TABLE XV

COLORFASTNESS DATA

15		COLORFASTNESS DATA					
		Grey Scale Rating					
		Nominal Comp.1 Add-on, % owf	Lightfastness, AFU		Ozonefastness, cy		NO2* Fastness, cy
Trial I.D.			20	40	1	3	1
20	1	-	4.0	3.5	3.5	2.0	3.0
	2	5.0	4.5	4.0	4.0	3.0	2.5
	3	6.0	4.5	4.0	4.0	3.5	2.5
	4	7.0	4.5	4.0	4.0	3.5	2.5
25	5	8.0	4.5	4.0	4.5	4.0	2.5

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TABLE XVI  
ANALYSIS DATA

Trial I.D.	Nominal Comp.1 Add-on, % owf	Nominal Comp.1 A/T Liquor g/l*	Anal. A/T Conc. of sac g/l	s.a.c.		Anal. Add-on from Carpets % owf	Anal. sac in Rinse Bath g/l
				Based on	Anal.		
					A/T Liquor % owf		
10	1	-	-	-	-	N/D**	N/D
	2	5.0	12.5	11.8	4.7	5.1	N/D
	3	6.0	15.0	15.0	6.0	7.3	N/D
	4	7.0	17.5	19.6	7.8	7.5	N/D
	5	8.0	20.0	23.5	9.4	8.3	N/D
15	* Applied at 400% w.p.u.						
	** Non-detected						

#### Example 4

The process and conditions of dyeing formulations of Example 2 using Composition 2 were repeated with and without citric acid to adjust pH in the continuous aftertreatment application process of this invention the fabric was in 32 ounce per square yard cut pile construction of a 1185 denier bulked continuous filament, Superba H/S, ~~Beck~~-dyed grey. The fiber had been treated with fluorocarbon for antisoiling properties. Also all dispersing agents (Tamol) were omitted from Composition 2 for another set of samples. Epsom salt (49% MgSO<sub>4</sub>) was added to another set of samples. Citric acid was used as a rinse and in the application liquor. Use of citric acid in the treatment liquor or to adjust pH resulted in improved yellowing of the sulfonated aromatic condensate treated fiber. The combination of Epsom salt and citric acid further reduced the tendency to yellow whether due to exposure to ozone or to NO<sub>2</sub>. The following tables provide application conditions and results.

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TABLE XVII

EVALUATION OF CITRIC ACID -  
USE FOR CONCENTRATE pH ADJUSTMENT ON  
LIGHT INDUCED YELLOWING

5

APPLICATION AND ANALYSIS DATA

	Sample I.D.	s.a.c.Used	Nominal s.a.c. Applied, %	Other Agents/Conc.
10	6	Not Treated	0	-
	1	Composition 2	3.0	-
	2	Composition 2	3.0	-
	3	Composition 2	3.0	-
15	4	Composition 2	3.0	-
	5	Composition 2	3.0	-
	7	Composition 2	3.0	0.09 g/l Citric Acid
	8	Composition 2	3.0	0.09 g/l Citric Acid
	9	Composition 2	3.0	0.75 g/l Citric Acid
20	10	Composition 2	3.0	0.75 g/l Citric Acid
	11	Intratex N	3.0	Citric Acid (pH adj) *
	12	Intratex N	3.0	Citric Acid (pH adj) *
	13	Intratex N	3.0	0.72% owf Epsom Salt & Citric Acid (pH adj) *
25	14	Intratex N	3.0	0.72% owf Epsom Salt & Citric Acid (pH adj) *

\* 1.25 g/l citric acid required for pH adjustment.

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TABLE XVII (CONTINUED)

EVALUATION OF CITRIC ACID -  
USE FOR CONCENTRATE pH ADJUSTMENT ON  
LIGHT INDUCED YELLOWING

5	APPLICATION AND ANALYSIS DATA			
	Sample I.D.	Appl. pH	Rinse	s.a.c. Analyzed %
10	6	7.5	Normal - Cold Water	0
	1	3.1	Normal - Cold Water	1.87
	2	3.1	0.09 g/l Citric (pH 4.1)	2.18
	3	3.1	0.25 g/l Citric (pH 3.5)	2.29
	4	3.1	0.75 g/l Citric (pH 3.1)	2.32
15	5	3.1	5.9 g/l Citric (pH 2.5)	2.44
	7	3.1	Normal - Cold Water	1.90
	8	3.1	No Rinse	2.10
	9	2.9	Normal - Cold Water	2.04
	10	2.9	No Rinse	2.30
20	11	3.0	Normal - Cold Water	2.67
	12	3.0	No Rinse	2.39
	13	3.0	Normal - Cold Water	2.89
	14	3.0	No Rinse	2.89
25	Notes: Carpet temperature before A/T ranged from 132 to 138°F (55.6-58.9°C). A/T liquor temperature was 183 to 185°F (83.9-85°C). Actual temperature after A/T ranged from 163 to 171°F (72.8-77.2°C)			

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TABLE XVIII

EVALUATION OF CITRIC ACID -  
USE FOR CONCENTRATE pH ADJUSTMENT ON  
LIGHT INDUCED YELLOWING

STAINING PERFORMANCE  
AND CHANGE-OF-SHADE DATA

5

		Stain Rating (0=best,10=worst)						Shade Change*
Sample		Time Before Blotting With Water, Hr						
I.D.		0.05	0.5	1	4	8	24	
10	6	9.5	9.5	9.5	9.5	9.5	9.5	-
	1	0	0.25	0.5	1.0	1.0	1.0	M-N
	2	0	0.25	0.25	0.5	0.5	0.75	M-N
	3	0	0.25	0.25	0.5	0.75	1.0	M-N
15	4	0	0.25	0.25	0.5	0.75	0.75	M-N
	5	0	0.25	0.5	0.5	1.0	1.5	M-N
	7	0	0.25	0.25	0.25	0.25	0.25	M-N(Y)
	8	0	0.25	0.25	0.5	1.0	1.0	M-N(B)
	9	0	0.25	0.25	0.25	0.5	0.75	M-N(B)
	10	0	0.1	0.1	0.5	0.5	0.5	M-N
20	11	0.1	0.5	0.5	0.5	0.5	1.0	M-N
	12	0	0.25	1.0	2.0	2.5	2.5	M-N
	13	0	0.25	0.25	0.25	0.25	0.25	M-N(B)
	14	0	0.25	0.5	0.5	0.5	0.5	M-N(B)

25 \* M=marginal, N=none, Y=yellow, B=blue



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TABLE XIX

EVALUATION OF CITRIC ACID -  
USE FOR CONCENTRATE pH ADJUSTMENT ON  
LIGHT INDUCED YELLOWING

COLORFASTNESS DATA

5

		Grey Scale Rating						
		Lightfastness, AFU		Ozonefastness, cy				NO <sub>2</sub> * Fastness, 1 cy
10	Sample I.D.	20	40	1	2	3	5	
	6	4.0	3.5	3.0	2.5	1.5	1.0	2.5
	1	2.5	3.0	3.0	2.5	2.5	2.0	1.5
	2	2.5	3.0	3.0	2.5	-	-	1.5
	3	2.5	3.0	3.0	2.5	-	-	1.5
15	4	3.0	3.0	3.5	3.0	3.0	2.5	1.5
	5	3.0	3.0	3.5	3.0	-	-	2.0
	7	2.5	3.0	3.0	3.0	-	-	1.5
	8	2.5	3.0	3.0	2.5	-	-	1.5
	9	3.0	3.0	3.5	3.0	3.0	2.5	2.0
20	10	2.5	3.0	3.5	3.0	3.0	2.5	1.5
	11	3.0	3.5	3.5	3.0	-	-	2.0
	12	3.0	3.5	3.5	3.0	-	-	2.0
	13	4.0	3.5	3.5	3.0	3.0	3.0	2.5
	14	4.0	3.5	3.5	3.5	3.5	3.0	2.5

25

\* High R.H nitrogen dioxide (AATCC TM-164).

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TABLE XX

EVALUATION OF CITRIC ACID -  
USE FOR CONCENTRATE pH ADJUSTMENT ON  
LIGHT INDUCED YELLOWING

5

BENZOYL PEROXIDE SPOTTING DATA\*

Sample I.D.	Spot Visibility (0=Invisible; 10=Bright)				
	Benzoyl Peroxide Conc., % Soln. in Acetone				
	0.01	0.05	0.10	1.0	5.0
10 6	3.0	7.0	8.0	9.0	9.5
1	0.75	5.5	6.5	7.5	8.0
13	0	0.25	0.5	1.5	2.5
14	0	0.25	0.5	1.5	2.5

15 \* Sample spotted with 1 ml of benzoyl peroxide solution  
and exposed in chamber at 90°F (32.2°C) and 80% R.H. for  
three days.

Example 5

20 The process on the fabric of Example 4 was  
repeated, also using Composition 2 with and without the  
Tamol dispersant, and also adding NH<sub>4</sub>SCN to show its  
benefits.

Following are the standard continuous process  
aftertreatment conditions used:

25 Prewet/heat carpet at 195°F (90.6°C) and 100%  
w.p.u. to achieve a carpet temperature prior to treatment  
of 135 to 140°F (57.2 to 60°C).

30 Apply A/T liquor at 400% w.p.u. and 175 to 180°F  
(79.4 to 82.2°C) to achieve a post-A/T carpet temperature  
of 160 to 170°F (71.1 to 76.7°C).

Aftertreatment, 30-second dwell time before  
washing (at 40:1 liquor ratio), hydroextraction and  
drying.

Summary of Results35 1. Application

The addition of NH<sub>4</sub>SCN to the Composition 2  
bath was found to affect pH only at the lowest  
concentration. This is an indication of the buffering  
capacity of Composition 2 solutions.

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During the make-up and running of the treatment solutions, it was observed that considerably more foaming occurs with Intratex-N alone than does Composition 2.

## 2. Stain Resistance

5                   Composition 2 tended to exhibit better staining performance than Intratex N alone at comparable levels. The differences between the two diminish as the overall concentration increases.

10                   The addition of  $\text{NH}_4\text{SCN}$  did not adversely affect the staining performance and, in fact, samples with  $\text{NH}_4\text{SCN}$  tended to perform better than corresponding samples without  $\text{NH}_4\text{SCN}$ . This difference diminishes as the Intratex N concentration increases and overall performance improves.

## 15                   3. Light and $\text{NO}_2$ Induced Yellowing (Table XXIII)

                  Intratex N and Tamol SN (by themselves) were found to behave differently when exposed to light. Intratex N yellows/browns severely at short light exposures (20 afu). This yellowing or browning then fades  
20 as the lightfastness exposure is continued. Tamol, on the other hand, greens when exposed to 20 afu and upon continued exposure the green fades to yellow. The overall rating of the shade change does not necessarily improve from the 20 to 40 afu exposures. The severity of shade  
25 change is about equal for Intratex N and Tamol SN.

                  The break of Composition 2 at short lightfastness exposures (20 afu) appears as a hybrid of Intratex N and Tamol SN alone (at the respective levels in Composition 2).

30                   At both 20 and 40 afu, the break of Composition 2 samples were no worse-to-slightly better than the corresponding Intratex N and Tamol SN only samples.

                  The addition of  $\text{NH}_4\text{SCN}$  gives a slight improvement in light induced yellowing. The reduction is  
35 greatest at the lower Intratex N levels and decreases as the Intratex N level increases. Similar behavior is observed between Composition 2 and Intratex N alone, but Tamol SN is less affected.

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Yellowing diminishes as the  $\text{NH}_4\text{SCN}$  level increases. The yellowing is significantly reduced using approximately 0.3% owf  $\text{NH}_4\text{SCN}$  for every 1.0% owf Intratex N.

5            Tamol SN was found to be unaffected by exposure to  $\text{NO}_2$ , while Composition 2 and Intratex N yellowed severely. The addition of  $\text{NH}_4\text{SCN}$  improved  $\text{NO}_2$  yellowing only slightly, but not enough to raise Grey Scale ratings above 1-2.

10            4. Ozonefastness (Table XXIII)

Intratex N had a significant impact on ozonefastness, both alone and as Composition 2. While overall fastness ratings tended to be better at extended cycles compared to the nontreated control, a significant  
15            yellowing occurs.

The yellowing of Intratex N overwhelms any improvement achieved by the addition of  $\text{NH}_4\text{SCN}$ . Samples incorporating  $\text{NH}_4\text{SCN}$  tend to yellow less when exposed to ozone and higher levels yield more improvement. The  
20            significant improvement in ozonefastness of  $\text{NH}_4\text{SCN}$  alone was not achieved, but were improved over nontreated samples.

5. Benzoyl Peroxide Spotting (Table XXIV)

The dispersant, Tamol SN, had no effect on the  
25            benzoyl peroxide spotting performance. Table XXIV shows the benzoyl peroxide performance identical when 0.3% owf  $\text{NH}_4\text{SCN}$  is applied with either Composition 2 or s.a.c. at several levels.

The performance of  $\text{NH}_4\text{SCN}$  is not effected at  
30            varied s.a.c. levels (as Composition 2 or alone) as shown in Table XXIV.

Benzoyl peroxide spotting improves as the  $\text{NH}_4\text{SCN}$  concentration is increased from 0.3 to 0.6% owf. The improvement becomes more noticeable at the highest  
35            benzoyl peroxide concentration and probably beyond.

Conclusions

The dispersant, Tamol SN, contributes to the light induced yellowing of Composition 2 but is not the

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sole cause. Elimination of Tamol SN from Composition 2 would not significantly improve or resolve yellowing on Superba H/S substrates. The elimination of Tamol SN could reduce staining performance slightly at lower add-on's and  
5 increase the foaming of the treatment liquor upon spray application.

Intratex N is the sole cause of yellowing upon exposure to NO<sub>2</sub> of Composition 2.

Tamol does not interfere with any of the NH<sub>4</sub>SCN  
10 benefits.

Intratex N has a significant impact on ozonefastness (yellows) and overwhelms the ozonefastness improvement benefits of NH<sub>4</sub>SCN. There is, however, a reduction in the yellowing and an improvement over  
15 Composition 2 alone at a nominal 0.6% owf NH<sub>4</sub>SCN.

NH<sub>4</sub>SCN has no adverse impacts on Composition 2 stain blocking benefits.

There is a reduction in light induced yellowing when NH<sub>4</sub>SCN is applied with Composition 2. The degree of  
20 improvement has varied from marginal to significant during all internal trials. Higher NH<sub>4</sub>SCN levels always yield greater improvement.

Benzoyl peroxide spotting performance may be further improved, particularly at higher benzoyl peroxide  
25 concentrations, by increasing the NH<sub>4</sub>SCN level to 0.6% owf.

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TABLE XXI

APPLICATION AND ANALYSIS DATA

		Nominal s.a.c. Applied as Comp.2, %	Nominal s.a.c. Applied* %	Nominal Tamol SN Applied* %	Nominal NH <sub>4</sub> SCN Applied %	pH	s.a.c. Anal. (As Rec'd) %
5	Sample I.D.						
	1	-	-	-	-	7.4	0
10	28	-	-	-	0.3	2.8	0
	2	1.0	-	-	-	3.5	1.05
	3	1.0	-	-	0.3	4.6	1.08
	4	1.0	-	-	0.6	4.7	1.05
	5	2.0	-	-	-	3.1	1.91
15	6	2.0	-	-	0.3	3.2	1.93
	7	2.0	-	-	0.6	3.2	2.16
	8	3.0	-	-	-	3.0	3.19
	9	3.0	-	-	0.3	3.0	3.58
	10	3.0	-	-	0.6	3.0	3.24
20	11	4.0	-	-	-	2.8	3.23
	12	4.0	-	-	0.3	2.9	4.20
	13	4.0	-	-	0.6	2.9	3.90
	14	-	2.0	-	-	3.2	2.10
	15	-	2.0	-	0.3	3.2	2.43
25	16	-	3.0	-	-	2.9	3.83
	17	-	3.0	-	0.3	2.8	4.20
	18	-	4.0	-	-	2.7	4.97
	19	-	4.0	-	0.3	2.7	4.73
	20	-	-	1.93	-	2.9	-
30	21	-	-	1.93	0.3	2.9	-
	22	-	-	2.90	-	2.8	-
	23	-	-	2.90	0.3	2.8	-
	24	-	-	3.89	-	2.8	-
	25	-	-	3.89	0.3	2.9	-

35 \* Materials applied as supplied, not blended or part of a composition.

Notes: Carpet temperature before A/T ranged from 132 to 144°F (55.6-62.2°C).

40 A/T liquor temperature was 178 to 183°F (55.6-62.2°C).

Actual temperature after A/T ranged from 158 to 172°F (70-77.8°C)

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TABLE XXII  
STAINING PERFORMANCE DATA

5	Sample I.D.	Stain Rating (0=best, 10=worst)					
		Time Before Blotting With Water, Hours					
		0.05	0.5	1	4	8	24
10	1	9.5	9.5	9.5	9.5	9.5	9.5
	2	0	1.0	2.0	3.5	3.5	3.5
	3	0	1.0	1.5	2.0	3.0	3.0
	4	0	0.5	0.75	1.5	1.0	1.0
	5	0	0.25	0.5	1.0	1.0	1.5
	6	0	0.25	0.25	1.0	1.0	1.0
	7	0	0	0.25	0.5	0.5	0.5
	8	0	0.25	0.25	0.75	0.75	0.75
15	9	0	0	0.10	0.25	0.25	0.25
	10	0	0	0	0.25	0.5	0.5
	11	0	0	0.1	0.5	0.25	0.5
	12	0	0	0.1	0.25	0.25	0.5
	13	0	0	0	0.25	0.25	0.25
20	14	0	0.5	1.0	1.5	2.0	3.0
	15	0	0.5	1.0	1.25	2.0	2.5
	16	0	0.25	0.25	0.5	0.5	0.5
	17	0	0	0.25	0.5	0.25	0.25
	18	0	0.1	0.1	0.25	0.25	0.25
25	19	0	0	0	0.25	0.1	0.1

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TABLE XXIII  
COLORFASTNESS DATA

5		Grey Scale Rating						
		Lightfastness,		Ozonefastness, cy				NO <sub>2</sub> * Fastness, 1 cy
		AFU						
		Sample I.D.	20	40	1	2	3	
10	1	4.0	3.0	3.0	2.5	2.0	1.0	3.0
	28	4.0	3.0	3.5	3.0	3.0	3.0	3.0
	2	2.5	3.0	3.0	2.5	2.5	2.0	1.5
	3	3.0	3.5	3.0	2.5	2.5	2.5	1.5
	4	3.5	3.5	3.0	2.5	2.5	2.5	1.5
	5	2.5	2.5	2.5	2.5	2.0	2.0	1.5
15	6	2.5	2.5	3.0	2.5	2.5	2.0	1.5
	7	3.0	3.0	3.0	2.5	2.5	2.5	1.5
	8	2.0	2.5	2.5	2.5	2.0	2.0	1.5
	9	2.0	2.5	2.5	2.5	2.5	2.0	1.5
	10	2.5	2.5	3.0	3.0	2.5	2.5	1.5
	11	2.0	2.0	2.5	2.5	2.0	2.0	1.5
20	12	2.0	2.0	2.5	2.5	2.0	2.0	1.5
	13	2.5	2.5	3.0	3.0	2.5	2.5	1.5
	14	2.5	2.5	2.5	2.5	2.0	2.0	1.5
	15	3.0	2.5	2.5	2.5	2.0	2.0	1.5
	16	2.0	2.0	2.5	2.5	2.0	2.0	1.5
	17	2.5	2.5	2.5	2.5	2.5	2.0	1.5
25	18	2.0	2.0	2.0	2.0	2.0	2.0	1.5
	19	2.5	2.0	2.5	2.5	2.0	2.0	2.0
	20	2.5	2.5	2.5	2.5	-	-	2.5
	21	2.5	2.5	3.0	3.0	-	-	3.0
	22	2.0	2.0	3.0	2.5	-	-	3.0
	23	2.0	2.0	3.0	2.5	-	-	3.0
30	24	2.0	2.0	3.0	2.5	-	-	2.5
	25	2.0	2.0	3.0	2.5	-	-	3.0

35 \* High R.H nitrogen dioxide (AATCC TM-164).



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TABLE XXIV  
BENZOYL PEROXIDE SPOTTING DATA\*

5	Sample I.D.	Spot Visibility (0=Invisible;10=Bright)				
		Benzoyl Peroxide Conc., % Soln. in Acetone				
		0.005	0.01	0.05	0.1	1.0
	1	0.5	1.5	6.5	8.0	9.0
	28	0	0	0.75	1.0	8.0
	2	0.25	2.0	6.75	8.0	8.5
10	3	0	0	1.25	4.0	7.0
	4	0	0	0.25	0.5	2.0
	5	0.5	1.75	5.5	6.5	7.5
	6	0	0	0.5	1.0	2.0
	7	0	0	0.1	0.75	3.0
15	8	0.25	2.0	7.25	7.5	7.5
	9	0	0	0.5	1.25	2.0
	10	0	0	0.25	0.5	0.75
	11	1.0	2.5	7.5	8.0	8.5
	12	0	0	0.5	1.0	3.0
20	13	0	0	0.1	0.5	1.25
	14	0.5	1.5	6.5	7.5	8.0
	15	0	0	0.5	1.0	2.0
	16	-	-	-	-	-
	17	-	-	-	-	-
25	18	0.25	1.0	6.5	7.5	8.5
	19	0	0	0.5	0.75	1.75

\* Sample spotted with 1 ml of benzoyl peroxide solution and exposed in chamber at 90°F (32.2°C) and 80% R.H. for three days.

30

Example 6

This example demonstrates the two-step, batch-batch (beck-beck) process embodiment of this invention.

5           Prior art has shown that application of sulfonated aromatic condensates (stain blockers) to nylon improves resistance to staining by most food colors. In the prior art, the preferred mode of application has been a low temperature (120° to 180°F (48.9 to 82.2°C) treatment with the stain blocker after dyeing has been completed. Also, prior art includes application of stain blockers concurrent with dye application. This invention embodies application of a portion of the total stain blocker concurrently with dye application, and application of the remainder in a low temperature aftertreatment step. (two-step process).

10           The two-step process results in a level of stain performance superior to that which is achieved by the prior art at the same total add-on concentration of stain blocker. In addition, use of ammonium thiocyanate in the aftertreatment step improves dye fastness to ozone, benzoyl peroxide (acne medications) and light.

15           It is theorized that the improvement over prior art is achieved by maximization of the concentration of stain blocker in a thin zone near the fiber surface and that this condition results in better stain resistance. The two-step process promotes this condition by sorption of a portion of the stain blocker during the dyeing operation which is fully penetrated into the cross-section of the nylon fiber. The sorption of the portion of stain blocker subsequently applied in the low temperature aftertreatment step is retarded by the presence of the existing portion already on the fiber, therefore, increasing the effective concentration near the fiber surface. The presence of magnesium sulfate in both steps of the process accelerates rate of sorption of the stain blocker by increasing the bath electrolyte concentration

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and by complexing with the stain blockers thus reducing molecular mobility in the nylon.

Example 6 - Part 1

This example shows that two-step process is superior to either concurrent or aftertreatment.

Carpet Fabric:

1185 denier fluorocarbon treated Superba Heat Set

Process:

A total of 2.0% owf Intratex N was applied to carpet.

The total was distributed between dyebath and aftertreatment in the following ways:

	<u>Dyebath, %</u>	<u>Aftertreatment, %</u>
	0	100
15	50	50
	100	0

Varying amounts of Magnesium Sulfate were used (0% owf to 4% owf).

Dyebath conditions were typical of industry practice.

Dyeing procedure as follows:

1. Load fabric and wet out at 20:1 Liquor Ratio
2. Add 1.0% owf Dowfax 2Al-sodium mono-and didodecyl disulfonated diphenyl oxide (45% active)
3. Add the specified amount of Intratex N-1
4. Add the specified amount of Magnesium Sulfate
5. Run 5 minutes
6. Add 0.5% Sequestrene 30A (EDTA) or equiv.
7. Add 1% owf ammonium sulfate
8. Add 0.5% owf ammonium hydroxide
9. Add predissolved dyes
10. Run 10 minutes
11. Raise temperature to boil
12. Boil 30 minutes
13. Drop and rinse cold

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14. Aftertreat if indicated

Aftertreatment procedure as follows:

1. Refill Beck at 20:1 Liquor Ratio
2. Add specified amount of Magnesium Sulfate
- 5 3. Add specified amount of Intratex N1
4. Run 10 minutes
5. Lower pH to 2.0 to 2.1 with sulfamic acid
6. Raise temperature to 160°F (71.1°C).
7. Hold at temperature 20 minutes
- 10 8. Drop bath and rinse cold

Performance:

Reference samples Nos. 17 through 31 in Table XXV. Samples 23, 24 and 25 prepared with the 50%/50% two-step process are superior. Those samples which passed the dip test were further tested by the drop test.

Test Protocols:

1. "Dip Test" - Immerse a 5 gram sample of unfinished carpet into a large excess of Cherry Kool-Aid (unsweetened) at room temperature for 30 minutes. Rinse with cold water, dry and assess the stain.
- 20 2. "Drop Test"- Drop 30 ml. Cherry Kool-Aid<sup>1</sup> (unsweetened) onto the finished carpet from a height of 12 inches. Allow to stand for seven hours. Blot with paper towels using water spray to aid in removal.

Example 6 - Part 2

This example shows use of ammonium thiocyanate in two-step process for improved resistance to benzoyl peroxide and light fading.

Carpet Fabric:

1700 denier Superba Heat Set (High ICP fiber)

Process:

Using the process of Part 1, a total of 2.8% Intratex N was applied using the 50%/50% two-step mode. A second sample was prepared in the same way but an Intratex N pre-formulated mixture containing ammonium thiocyanate (Composition 3) was used in the aftertreatment step. Composition 3 is 40% Intratex N-1, 12% ammonium thiocyanate, 21.5% Monawet MB45, 26.5% Water.

<sup>1</sup> Registered ™ of General Foods Corporation.

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Performance:

Reference samples "H" and "I" in Tables XXVI to XXVIII. Using the "Drop Test" Protocol from Example 1, sample "I" has good stain resistance (somewhat poorer than "H") but very significant improvements in benzoyl peroxide and light fading.

Example 6 - Part 3

This example shows that 50%/50% two-step mode is preferred and the 2% magnesium sulfate is optimum.

10      Carpet Fabric:

1185 denier fluorocarbon treated autoclave Heat Set (high ICP fiber)

Process:

Using the process of Part 1, a total of 3.0% Intratex N-1 was applied using the two-step mode.

The total was distributed between dyebath and aftertreatment in the following ways:

	<u>Dyebath, %</u>	<u>Aftertreatment, %</u>
	0	100 .
20	5	95
	10	90
	20	80
	30	70
	50	50

25      Varying amounts of magnesium sulfate were used (0% owf to 4% owf)

Performance:

Reference samples 2 through 23 Table XXIX. Using the test protocols from Example 1, samples 20 through 23 (50%/50% application mode) have best stain resistance. Sample 20 is best of group (uses 2% and 2% owf magnesium sulfate).

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TABLE XXV

	No.	Dyebath		Aftertreatment		K/A** "Dip" Test***
		s.a.c.	ES*	s.a.c.	ES*	
5	1	0	0	-	-	F
	2	0	0	1.6	0	F
	3	0	0	1.6	2.0	F
	4	0	0	1.6	4.0	F
	5	0.8	0	0.8	0	F
10	6	0.8	0	0.8	2.0	F
	7	0.8	0	0.8	4.0	F
	8	0.8	2.0	0.8	0	S
	9	0.8	2.0	0.8	2.0	P
	10	0.8	2.0	0.8	4.0	S
15	11	0.8	4.0	0.8	0	S
	12	0.8	4.0	0.8	2.0	S
	13	0.8	4.0	0.8	4.0	P
	14	1.6	0	-	-	F
	15	1.6	2.0	-	-	F
20	16	1.6	4.0	-	-	S
	17	0	0	2.0	0	F
	18	0	0	2.0	2.0	F
	19	0	0	2.0	4.0	F
	20	1.0	0	1.0	0	F
25	21	1.0	0	1.0	2.0	F
	22	1.0	0	1.0	4.0	F
	23	1.0	2.0	1.0	0	P
	24	1.0	2.0	1.0	2.0	P
	25	1.0	2.0	1.0	4.0	P
30	26	1.0	4.0	1.0	0	S
	27	1.0	4.0	1.0	2.0	P
	28	1.0	4.0	1.0	4.0	P
	29	2.0	0	-	-	F
	30	2.0	2.0	-	-	F
35	31	2.0	4.0	-	-	F
	32	0	0	2.8	0	F
	33	0	0	2.8	2.0	F

\* Epsom salt

\*\* Kool Aid

40 \*\*\*F=fail P=pass S=slight stain

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TABLE XXV (CONTINUED)

5	No.	<u>Dyebath</u>		<u>Aftertreatment</u>		<u>K/A "Dip"</u> <u>Test</u>
		<u>s.a.c.</u>	<u>ES*</u>	<u>s.a.c.</u>	<u>ES*</u>	
	34	0	0	2.8	4.0	F
	35	1.4	0	1.4	0	F
	36	1.4	0	1.4	2.0	F
	37	1.4	0	1.4	4.0	F
10	38	1.4	2.0	1.4	0	S
	39	1.4	2.0	1.4	2.0	P
	40	1.4	2.0	1.4	4.0	P
	41	1.4	4.0	1.4	0	P
	42	1.4	4.0	1.4	2.0	P
15	43	1.4	4.0	1.4	4.0	P
	44	2.8	0	-	-	F
	45	2.8	2.0	-	-	P
	46	2.8	4.0	-	-	P

P = Pass (No Stain)

20 F = Fail (Noticeably Stained)

S = Slight Stain (Just Detectable)

\* Epsom salt

TABLE XXV (Continued)

25	No.	7-Hour Kool-Aid Staining*	<u>Gray Scale</u>	
			<u>Xenon Light-Fastness 20 AFU</u>	<u>Shade Change</u>
	1	7.5	3.0	-
	2	-	3.0	3.5
30	3	-	3.0	3.5
	4	-	3.5	3.0
	5	-	3.0	3.0
	6	-	2.5	4.0
	7	-	3.0	3.5
35	8	1.5	3.5	3.0
	9	0.75	3.5	3.5
	10	1.0	3.5	3.0
	11	1.0	3.5	3.0
	12	0.75	3.5	2.5
40	13	0.25	4.0	3.0

\*Drop test

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TABLE XXV (CONTINUED)

		Gray Scale		
5	No.	7-Hour Kool-Aid Staining	Xenon	Shade Change
			Light-Fastness 20 AFU	
	14	-	2.5	3.5
	15	-	2.0	3.5
	16	1.0	3.0	3.5
	17	-	4.0	3.5
10	18	-	3.5	3.5
	19	-	4.0	3.0
	20	-	4.0	3.5
	21	-	3.5	3.5
	22	-	3.5	3.5
15	23	0.5	4.0	3.0
	24	0	3.5	3.5
	25	0.1	3.5	3.5
	26	0.5	3.5	3.5
	27	0	3.0	3.5
20	28	0	3.0	3.5
	29	-	2.5	3.0
	30	-	2.5	3.0
	31	-	2.5	3.0
	32	-	3.5	3.0
25	33	-	4.0	3.5
	34	-	4.0	3.0
	35	-	2.5	3.5
	36	-	2.5	3.5
	37	-	2.5	2.5
30	38	0.5	2.0	3.5
	39	0.1	2.5	3.5
	40	0	2.5	3.5
	41	0	3.0	3.5
	42	0	3.0	4.0
35	43	0	3.0	3.5
	44	-	2.0	2.5
	45	0.1	2.5	2.5
	46	0.1	3.0	2.5



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TABLE XXVI

No.	Description	Original Samples Before Blot, Hours	
		1	
5	A Control		7.50
	Aftertreatments		
	B 5.0% Intratex N-1+4% ES*		0.10
	C 10% Composition 3		0.75
	D 10% Composition 3+4% ES		0.75
10	E 12.5% Composition 3		0.25
	Two-Step		
		1	2
	F 1.0% IntratexN-1+2.0%ES	1.0% Intratex +2.0%ES	4.50
	G 1.4% IntratexN-1+2.0%ES	1.4% Intratex +4.0%ES	1.00
15	H 1.4% IntratexN-1+4.0%ES	1.4% Intratex +4.0%ES	0.10
	I 1.4% IntratexN-1+2.0%ES	3.5% Comp. 3 +4.0%ES	1.00
	* ES-Epsom salt		

No.	Original Samples Before Blot, Hours **			s.a.c. by analysis %	Steam Cleaned Before Blot, Hours			
	4	7	24		1	4	7	24
20	A	8.00	8.00	8.00	-	-	-	-
	B	0.25	0.50	0.50	13.58*	2.00	3.50	3.00
25	C	1.00	1.50	1.00	4.45	2.50	4.00	3.50
	D	1.00	1.00	1.50	4.64	4.00	3.00	4.00
	E	1.00	1.00	1.50	5.83	1.50	4.50	3.50
	F	3.50	4.00	3.00	1.69	6.00	5.50	6.50
	G	2.00	2.00	1.50	2.14	4.00	4.00	5.00
30	H	0.10	0.25	0.50	2.57	5.50	4.50	4.50
	I	1.00	1.50	0.75	2.14	4.00	5.00	5.00
	* Error in application							

Note: All aftertreatments at pH = 2, 160°F ( °C).

\*\* Drop test 0=best 10 worst

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TABLE XXVII

		Spot Visibility *				
		<u>Benzoyl Peroxide Spotting Data</u>				
5	<u>No.</u>	<u>0.005</u>	<u>0.01</u>	<u>0.05</u>	<u>0.1</u>	<u>1.0</u>
	A	3.50	6.50	7.50	9.00	9.00
	B	3.00	6.50	7.50	8.00	8.00
	C	0	0.50	1.00	2.00	2.50
	D	0	0.25	1.00	3.00	3.00
10	E	0	0.10	0.75	1.50	1.00
	F	3.00	6.50	7.50	8.00	9.00
	G	4.50	6.50	7.50	8.00	8.50
	H	4.00	6.00	7.00	8.00	8.50
	I	0.25	0.75	1.50	3.00	3.00
15	* 0 = Invisible; 10= Bright					

TABLE XXVIII

		<u>Gray Scale Rating</u>					
		Lightfastness,			Ozone Fastness,		No. 2 Fastness,
		<u>AFU</u>			<u>Cycles</u>		<u>Cycle</u>
		<u>20</u>	<u>40</u>	<u>60</u>	<u>1</u>	<u>2</u>	<u>1</u>
20	<u>No.</u>						<u>Shade Change</u>
	A	4	3	2-3	3-4	2-3	2
	B	3	2-3	2-3	4-5	4	2
25	C	4	3-4	3	4-5	4	2-3
	D	4	3-4	3	4	3-4	2-3
	E	4	3-4	3	4-5	4	3
	F	4-5	4	4	4-5	4	2-3
	G	4	3-4	3	4	3-4	2-3
30	H	3-4	3	3	4	3-4	2
	I	4	3	3-4	4	3-4	3

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TABLE XXIX

	No.	Dyebath %owf		Aftertreat %owf		Dip <sup>K/A</sup> Test**
		s.a.c.	ES*	s.a.c.	ES*	
5	1	0	0	-	-	23
	2	0	0	3.0	2.0	22
	3	0	0	3.0	4.0	21
	4	0.15	2.0	2.85	2.0	20
	5	0.15	2.0	2.85	4.0	17
10	6	0.15	4.0	2.85	2.0	13
	7	0.15	4.0	2.85	4.0	16
	8	0.3	2.0	2.7	2.0	14
	9	0.3	2.0	2.7	4.0	18
	10	0.3	4.0	2.7	2.0	12
15	11	0.3	4.0	2.7	4.0	15
	12	0.6	2.0	2.4	2.0	9
	13	0.6	2.0	2.4	4.0	19
	14	0.6	4.0	2.4	2.0	10
	15	0.6	4.0	2.4	4.0	11
20	16	0.9	2.0	2.1	2.0	7
	17	0.9	2.0	2.1	4.0	8
	18	0.9	4.0	2.1	2.0	5
	19	0.9	4.0	2.1	4.0	6
	20	1.5	2.0	1.5	2.0	1
25	21	1.5	2.0	1.5	4.0	4
	22	1.5	4.0	1.5	2.0	2
	23	1.5	4.0	1.5	4.0	3

\* ES Ep-Epsom salt

\*\* Forced ranking (K/A = Kool-Aid)

30 1 = Best

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TABLE XXIX (CONTINUED)

5	No.	7-Hour	Xenon	Shade	s.a.c. by
		Kool-Aid	Lightfastness		analysis
		<u>Staining*</u>	<u>20 AFU</u>	<u>Change</u>	<u>%</u>
	1	7.50	3-4	-	-
	2	2.50	4	4	3.78
	3	3.00	4	4-5	3.93
10	4	1.00	4	5	3.38
	5	1.50	3-4	5	3.48
	6	1.50	4	4-5	3.38
	7	1.50	4	4-5	3.60
	8	1.00	4-5	4-5	3.60
15	9	1.50	3	4	3.60
	10	1.00	3-4	4	3.38
	11	1.50	3	4-5	3.29
	12	1.00	4	4-5	3.24
	13	1.00	3-4	4	3.00
20	14	1.50	4	4-5	3.15
	15	1.50	3-4	4	3.22
	16	0.75	3	4	3.15
	17	0.50	3-4	4-5	3.00
	18	0.75	4	4-5	3.03
25	19	1.00	3-4	4	3.10
	20	0.10	3-4	4	2.72
	21	0.50	3-4	4	2.86
	22	0.10	3-4	4	2.82
	23	0.75	3	4-5	2.91
30	* drop test				

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Example 7

This example describes use of a sequestering agent in the continuous aftertreatment process of this invention. The general procedure was as in Example 2.

5 Experimental SummarySubstrate

1185 denier fluorocarbon treated Superba H/S in 32 ounce per square yard cut pile fabric construction and beck dyed into Argent Grey shade.

10 Continuously aftertreated using nominal add-on 15.9% owf Composition 2 (3.0% owf Intratex N) with no additional pH adjustment (actual pH 2.9).

Calquest ADP (Mfrs. Chem.) added to treatment bath containing Comp. 2 at levels corresponding to 0.5 and 15 1.0% owf.

Standard Continuous Process

Prewet/heat carpet at 195°F (90.6°C) and 100% w.p.u. to achieve a carpet temperature prior to treatment of 135 to 140°F (57.2 to 60°C).

20 Apply A/T liquor at 400% w.p.u. and 175 to 180°F (79.4 to 82.2°C) to achieve a post-A/T carpet temperature of 160 to 170°F (71.1 to 76.7°C).

After treatment, 30-second dwell time before washing (at 40:1 liquor ratio), hydroextraction and 25 drying.

Summary of Results

The change in the dyed shade was reduced (went more to the blue side) when the sequestering agent was used.

30 Light induced yellowing was improved between 1/2 to 1 gray scale unit at 20 AFU using the sequestering agent. No further improvement was noted going from the low to the high concentration. There also appeared to be more of an improvement (or fading) of the yellowing in 35 going from 20 to 40 AFU's when the sequestering agent was included.

Yellowing upon exposure to ozone was also minimized when the sequestering agent was included. Only a

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slight reduction in the yellowing upon exposure to nitrogen dioxide was observed.

There was no impact on staining, but a slight reduction in the Intratex N analyzed on carpet level was observed when the sequestering agent was used.

### Conclusions

The use of sequestering agent in the Composition 2 formulation shows reduced yellowing at low lightfastness exposures and upon exposure to ozone.

TABLE XXX

EFFECT OF SEQUESTERING AGENTS ON LIGHT INDUCED  
YELLOWING (NOMINAL 3.0% OWF INTRATEX N

ANALYSIS, STAINING PERFORMANCE,  
CHANGE-OF-SHADE AND COLORFASTNESS DATA

Sample I.D.	Nominal Comp. 2 Conc., % owf	Nominal Seq. Agent Conc., % owf*	Intratex N Analyzed, %	Stain Rating (0=best,10=worst)			
				Time Before Blotting With Water, Hours			
				0.05	0.5	1	4
1	N.T.	-	0	7.0	8.5	8.50	8.5
2	3.0	-	4.22	0	0	0	0.1
3	3.0	0.5	3.41	0	0	0	0.1
4	3.0	1.0	3.66	0	0	0	0.1

25

		Stain Rating (0=best,10=worst)				Grey Scale Rating			
		Time Before Blotting With Water, Hours		Shade Change	Light- fastness, AFU		Ozone- fastness cy		NO <sub>2</sub> *** Fast- ness, cy
Sample I.D.		8	24		20	60	1	2	1
30	1	8.5	8.5	-	3.5	2.5	3.0	2.5	2.5
	2	0.1	0.1	M(B)	2.5	3.0	3.0	2.5	1.0
	3	0.1	0.1	M-Y(B)	3.5	4.0	3.0	3.0	1.5
35	4	0.1	0.1	M-Y(B)	3.5	3.5	3.0	3.0	1.5

\* Calquest ADP (Manufacturers Chemical)

\*\* N.T. = Not treated

\*\*\* High R.H. Nitrogen Dioxide. AATCC TM-164.

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Other sequestering agents would also be useful, for example, the polyphosphates, such as Calgon which is sodium hexametaphosphate, aminocarboxylic acids, such as EDTA or ethylenediaminetetraacetic acid, the amino  
 5 alcohols, and the hydroxycarboxylic acids, including citric acid.

TABLE XXXI

ADDITION OF SEQUESTERING AGENTS TO  
 INHIBIT LIGHT INDUCED YELLOWING

10 (1185 Fluorocarbon Treated Superba Substrate,  
 Nominal 15.9% owf Composition 2 - 3.0% Intratex N)

Analysis and Colorfastness Data

	Sample I.D.	Additives	A/T pH	s.a.c. Analyzed
15	1	Not Treated	-	0
	2	No Additive (Comp. 2 only)	3.0	2.46
	3	0.50% owf Calquest ADP	3.3	2.95
	4	0.10% owf Sequestrene 30A	3.2	2.75
	5	0.25% owf Sequestrene 30A	3.7	3.02
20	6	0.50% owf Sequestrene 30A	3.3**	2.54
	7	0.10% owf SHMP*	3.0*	2.80
	8	0.25% owf SHMP*	3.3	2.95
	9	0.50% owf SHMP*	3.6	3.09

		Grey Scale Rating				
		Lightfastness,		Ozonefastness,		NO <sub>2</sub> * Fastness,
Sample		AFU		cy		cy
I.D.		20	40	1	2	1
25	1	5.0	4.5	3.0	2.5	2.5
	2	3.0	3.5	3.5	3.0	1.5
	3	3.0	3.5	4.0	3.0	2.0
	4	4.0	4.0	3.5	3.0	2.0
	5	4.0	3.5	4.0	3.0	2.0
30	6	4.0	3.5	3.5	3.0	2.0
	7	4.0	3.5	3.5	3.0	2.0
	8	3.5	3.5	3.0	2.5	2.0
	9	3.5	3.5	3.5	3.0	2.0

\* Sodium Hexametaphosphate.

40 \*\* Sulfamic Acid required to lower pH after the additive  
 added to A/T liquor.

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TABLE XXXIIADDITION OF SEQUESTERING AGENTS TO  
INHIBIT LIGHT INDUCED YELLOWINGSTAINING DATA

5

		<u>Stain Rating (0=best 10 worst)</u>					
		<u>Time Before Blotting</u>					
		<u>With Water, Hours</u>					
	<u>Sample I.D.</u>	<u>A/T pH</u>	<u>1</u>	<u>4</u>	<u>8</u>	<u>24</u>	<u>Shade Change*</u>
10	1	-	9.5	9.5	9.5	9.5	-
	2	3.0	0.25	0.25	0.75	1.25	M-N
	3	3.3	0.75	0.75	0.75	0.75	M-N
	4	3.2	0.25	0.75	0.75	0.75	M-N
	5	3.7	0.5	1.0	1.25	1.25	N
15	6	3.3	0.5	0.5	1.0	1.5	M-N
	7	3.0	0.25	0.75	0.75	0.75	N
	8	3.3	0.5	1.0	1.0	1.0	N
	9	3.6	0.25	0.5	1.0	1.0	N

\* M=moderate N=none

20

Example 8

Method for Exhausting Ammonium Thiocyanate Onto Dyed Nylon.  
Fiber to Improve its Resistance to Oxidizing Agents

Description of the Embodiment

25 Dyed carpet fiber, especially that made from  
nylon, whether or not it is treated with a sulfonated  
aromatic condensate or other treatments, is susceptible to  
significant color fading due to exposure to ozone, benzoyl  
peroxide and products containing chlorine. The problem  
was lessened to some extent when the dye industry changed  
30 over to acid dyes from disperse dyes. Acid dyes were less  
able to migrate and be destroyed by ozone because they  
were electronically bound to the nylon. However, the use  
of acid dyes did not eliminate these color fastness  
problems.



There are many antioxidants and antiozonants available on the market. These products are usually aromatic and contain amine or sulfur functionalities. These products have several disadvantages: aromatics usually yellow the fiber upon further heat treatment, and the amines and sulfur functionalities cause a reduction in nylon lightfastness. Also, these chemistries probably act as sacrificial agents and it has been difficult to apply enough onto the fiber to have long term benefit.

10           The thiocyanates, such as ammonium thiocyanate, are antiozonants that are well known. The cation of the thiocyanate may be ammonium, sodium, potassium, zinc, copper, ferrous, ferric, methyl or phenyl. They had the additional advantage over the other antioxidants in that they do not reduce lightfastness. However, it has not been economically possible to apply enough of the thiocyanate during dyeing to have long term effectiveness as it is also a sacrificial agent. (Ammonium thiocyanate also appears to agglomerate the dye molecules which also improves ozone fastness.)

20           In order to apply ammonium thiocyanate economically, it is necessary to devise a process in which it essentially exhausts onto the fiber. At pH=7 and 212°F ( °C) (normal dyeing conditions), the ammonium thiocyanate will not exhaust onto the fiber as it is water soluble and not very substantive to nylon. However, it has been found that at acidic pH's, especially at about pH 1.5 to pH 5, the ammonium thiocyanate will exhaust onto the nylon.

### 30   Comparison of Various Thiocyanates

A comparison was made of the performance of several organic and inorganic thiocyanate compounds which had been aftertreated onto fluorocarbon treated nylon carpet fiber knitted into sleeves at pH=2, 140°F (60°C),

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20:1 liquor:goods and 20 minutes. No dyes were added.

The following thiocyanates were evaluated:

	<u>Added as Received, %</u>	<u>Thiocyanate</u>	<u>Activity, %</u>
	0.30	NH <sub>4</sub> SCN	100
5	0.32	NaSCN	100
	0.38	KSCN	100
	0.48	CuSCN	100
	2.57	CH <sub>2</sub> (SCN) <sub>2</sub>	10
	3.13	Ph(S)N=CCH <sub>2</sub> SCN	30

10 The amounts added introduced an equivalent quantity of thiocyanate concentration onto the fiber.

The ammonium, sodium and potassium thiocyanates were all equally superior to untreated nylon in resistance to ozone, benzoyl peroxide and chlorine bleach fastness.

15 The other 15 thiocyanates were slightly more resistant to these color fade tests than the untreated nylon. The xenon lightfastness of all the samples were similar to untreated nylon except CuSCN which was more resistant and the phenyl-based thiocyanate which was much worse.

#### 20 Effect of pH

Using the same conditions as above but varying pH and using only NH<sub>4</sub>SCN, the percent exhaustion of NH<sub>4</sub>SCN onto fiber was measured at the pH levels shown.

	<u>pH</u>	<u>Exhaustion, %</u>
25	1	60
	2	60
	3	40
	4	10
	5	10
30	6	8
	7	9

#### Effect of Temperature

35 In another test at the same conditions pH 2 temperature was varied to achieve the following exhaustion levels.

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	<u>Temperature,</u>		<u>Exhaustion,</u>
	<u>°F</u>	<u>( °C)</u>	<u>%</u>
	75	23.9	70
	100	37.8	66
5	120	48.9	63
	140	60.0	60
	180	82.2	75
	200	93.3	98

Thus by raising the temperature, it is expected that more  
10 complete exhaustion can be achieved at higher pH levels.

In a separate test at the same conditions but  
varying time, it was found that time between 5 and 50  
minutes had little effect on exhaustion levels. On the  
other hand, increasing the concentration of  $\text{NH}_4\text{SCN}$  lowers  
15 the level of exhaustion. It was also found that putting  
increasing amounts of  $\text{NH}_4\text{SCN}$  on the fiber has only a very  
small effect on ozonefastness over 2,000 ppm, a little  
effect over 1,000 ppm, but a large effect between 0 and  
1,000 ppm. It was noted that the 4 E in the standard  
20 5-cycle AATCC ozonefastness changed from 6 at 500 ppm  
to only 2 at 1,000 ppm.

#### DISCUSSION

The above examples are but a few of the many  
embodiments and variations of this invention. One skilled  
25 in the art would be able to select the proper conditions  
and amounts of chemical compounds for other embodiments of  
this invention to achieve the results desired after  
learning the teachings of this invention, including the  
Examples and the broader teachings of the Summary of the  
30 Invention above. The broader teachings are based on  
economic, technical and practical limitations to practice  
the invention. However, it may sometimes be useful to  
operate outside these economic or practical limitations  
for special reasons.

35 The following discussion will describe some of  
the practical, economical and/or technical limitations of  
the parameters of the embodiments of this invention.

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First, regarding the operating conditions of the continuous aftertreatment method, including two-step application methods, of this invention, the following table lists reasons for the limitations given.

5	<u>Limitation Variation</u>	<u>Reason</u>
	preheat water temp. below 140°F (60°C) and carpet temp. below 130°F (54.4°C)	less uniform application during the following treatment and less effective or economic to heat carpet
10	preheat water temp. above 212°F (100°C) and carpet above 210°F (   °C)	atmospheric process, water cannot be heated above the boiling point
	less than 75% w.p.u. preheat step	less uniform, poor penetration
15	extracting to less than 30% w.p.u.	less uniform, poor penetration
	extracting to above 190% w.p.u.	dilutes following application liquor, less effective
20	application pH below 1.5	corrosive
	application pH above 5.5	less effective, due to compounds of aqueous soln. penetrating too deep into fiber, at very high pH no exhaustion of compositions
25	application less than 200% w.p.u.	less effective
	application over 650% w.p.u.	carpet fabric cannot hold much more aqueous solution
30	conc. of s.a.c. less than 0.25 g/l	less effective
	conc. of s.a.c. over 40 g/l	uneconomical
	application soln. temp. under 140°F (60°C) and	less effective
35	carpet temp. under 130°F (54.4°C)	
	application soln. temp. over 212°F (100°C) and carpet temp. over 210°F (99°C)	atmospheric process, water cannot be heated above the boil
40	less than 0.05% owf MgSO <sub>4</sub>	less effective
	more than 0.8% owf MgSO <sub>4</sub>	adverse color fastness results

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	less than 0.03% owf $\text{NH}_4\text{SCN}$	less effective
	more than 1% owf $\text{NH}_4\text{SCN}$	uneconomical
	less than 0.15% owf s.a.c.	less effective
	more than 7.5% owf s.a.c.	uneconomical
5	more than 6 or 3 parts to parts of s.a.c. of the respective dispersing agents	uneconomical, possible adverse chemical activity

10 The following table lists reasons for limitation parameters for the two-step, batch-batch method of this invention.

	<u>Limitation Variation</u>	<u>Reason</u>
	second step pH below 1.5	corrosive
15	second step pH above 5.5	less effective, due to compounds of aqueous soln. penetrating too deep into fiber, at very high pH no exhaustion of compositions
20	second step temp. below $110^\circ\text{F}$ ( $^\circ\text{C}$ )	uneconomical, takes too long
	second step temp. above $195^\circ\text{F}$ ( $^\circ\text{C}$ )	less effective, due to compounds of aqueous soln. penetrating too deep into fiber
25	first & second step liquor: fabric ratio below 10	less uniform, poor wetting and penetration
	first & second step liquor: fabric ratio above 100	uneconomical
30	first step temp. below $158^\circ\text{F}$ ( $70^\circ\text{C}$ )	uneconomical, nonuniform application, takes too long
	first step temp. above $212^\circ\text{F}$ ( $100^\circ\text{C}$ )	atmospheric process, water cannot be heated above the boil
35	first step treating time less than 15 minutes	blotches and streaks, nonuniform
	first step treating time over 90 minutes	uneconomical
40	second step treating time under 5 minutes	nonuniform application
	less than 0.05% owf fluorocarbon on pretreated fabric	does not provide anti-soiling effect
	over 0.4% owf fluorocarbon on pretreated fabric	uneconomical

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	Limitation Variation	Reason
	below 0.25% owf $\text{MgSO}_4$	ineffective
	over 4% owf $\text{MgSO}_4$	poor lightfastness, uneconomical, poor dyeing, shade changes
5	below 0.03% owf $\text{NH}_4\text{SCN}$	ineffective
	above 1% owf $\text{NH}_4\text{SCN}$	uneconomical
	below 0.15% owf s.a.c.	ineffective
10	above 7.5% owf s.a.c.	fabric discolors, fabric stiff, poor dye yield, yellowing

The benefits of the best mode of this invention using Composition 1 in a two-step, continuous-continuous process as described above in Example 1 are given below. Most or some of the individual benefits given are also achieved by the other embodiments of this invention.

- improved stain resistance, particularly for carpet fabric of high ICP nylon fiber,
- substantially eliminates light induced yellowing of sulfonated aromatic condensate treated fiber,
- reduces  $\text{NO}_2$  yellowing of sulfonated aromatic condensate treated fiber,
- improves resistance of dye on sulfonated aromatic condensate treated fiber to fading from ozone and oxidation by benzoyl peroxide,
- improves penetration of sulfonated aromatic condensate and treatment chemicals into the carpet fabric, including the base or backing,
- does not significantly impact the soil resistance of the fluorocarbon treatment on the fiber of the carpet fabric,
- improves durability of the sulfonated aromatic condensate and treatment chemicals to steam cleaning with high pH detergents.

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## WE CLAIM:

1. A method to continuously treat dyed nylon carpet fabric to impart improved resistance to staining comprising:

- 5           preheating said dyed carpet fabric with water at a temperature between about 140 and 212°F (60 and 100°C) to a wet pick-up of above about 75% by weight, and a carpet temperature of between about 130 and 210°F (54.4 and 99°C), then
- 10           extracting said water from said carpet fabric to a wet pick-up of between about 30 to 190% by weight, then applying an aqueous solution of an effective amount of a sulfonated aromatic condensate to said carpet fabric at a pH of between about 1.5 to 5.5, at a
- 15           concentration of between about 0.25 and 40 grams of solids of said condensate per liter of aqueous solution, at a wet pick-up of between 200 and 650% by weight, at an aqueous solution liquor temperature of between about 140 and 212°F (60 and 100°C), to achieve a carpet fabric temperature
- 20           between about 130 and 210°F (54.4 and 99°C), then holding said carpet in said aqueous solution for between about 0.5 to 90 seconds at a temperature above 130°F (54.4°C).

2. The method of claim 1 wherein the dyed carpet fabric also comprises an effective amount of a fluorocarbon compound intended to improve resistance to soiling of the carpet.

3. The method of claim 1 wherein said aqueous solution also contains an effective amount of a thiocyanate.

4. The method of claim 2 wherein said aqueous solution also contains an effective amount of a thiocyanate.

5. The method of claim 4 wherein said aqueous solution also contains an effective amount of dispersing agent.

6. The method of claim 1 wherein said aqueous

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solution also contains an effective amount of a salt having a divalent cation.

7. The method of claim 2 wherein said aqueous solution also contains an effective amount of a salt  
5 having a divalent cation.

8. The method of claim 3 wherein said aqueous solution is buffered with an effective amount of citric acid or any other acid with a sequestering agent, whereby yellowing of said carpet fabric is improved.

10 9. The method of claim 1 wherein preceding said initial preheating step a portion of said effective amount of said sulfonated aromatic condensate is added during dyeing of said carpet fabric, so that the total of effective amounts of sulfonated aromatic condensate in  
15 both steps is less than the total effective amount useful in either the first dye step, solely, or in the subsequent application step, solely, or so that a more effective degree of stain resistance of the carpet fabric is achieved at the same total of effective amounts of  
20 sulfonated aromatic condensate in said two steps as compared to the same amount in either step, solely.

10. The method of claim 9 wherein an effective amount of a salt having a divalent cation is also added during said dyeing so that stain resistance of the nylon  
25 fiber in the carpet fabric, especially an easily dyed nylon fiber having a high index of crystalline perfection and having a very open internal crystal polymer structure, is enhanced and durability to steam cleaning of said stain resistance is enhanced, or said effective amount of  
30 sulfonated aromatic condensate is lower to achieve the same level of stain resistance.

11. The method of claim 9 wherein said fabric comprises a fluorocarbon present before dyeing.

12. The method of improving stain resistance of nylon  
35 or wool fiber comprising treating said fiber with a combination of an effective amount of each of a sulfonated aromatic condensate and a thiocyanate, whereby improved



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resistance to oxidation by ozone or other strong oxidizing agents, such as benzoyl peroxide, is imparted to the fiber.

13. The method of improving stain resistance of nylon  
5 fiber, particularly fiber having a high index of crystalline perfection, for carpets comprising treating said fiber with a combination of an effective amount of each of a sulfonated aromatic condensate, thiocyanate and a salt having a divalent cation.

10 14. The method of claim 13 wherein said fiber also comprises an effective amount of fluorocarbon compound intended to enhance soil resistance of the fiber.

15 15. The method of claim 12 wherein an effective amount of citric acid or any acid with a sequestering agent is used to buffer the condensate and thiocyanate so that light induced yellowing of the stain resistant fiber is reduced.

20 16. The method of claim 13 wherein an effective amount of citric acid or any acid with a sequestering agent is used to buffer the condensate and thiocyanate so that light induced yellowing of the stain resistant fiber is reduced.

25 17. A method to dye and treat, in two batch steps, nylon carpet fabric to impart improved resistance to staining comprising

dyeing, in a first step, the undyed carpet fabric in a dye bath liquor in the presence of an effective amount of a sulfonated aromatic condensate in an aqueous solution at an elevated temperature, then  
30 removing the dye bath liquor from the dyed carpet fabric, then

rinsing the dyed carpet fabric, then  
applying, in a second step, another effective amount of a sulfonated aromatic condensate in an aqueous solution to said dyed carpet fabric, at a pH of between  
35 about 1.5 to 5.5 and at a liquor temperature of between about 110 to 195°F (60 to 91°C), so that the total of effective amounts of sulfonated aromatic condensate in

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both steps is less than the total effective amount useful in either the first dye step, solely, or in the subsequent application step, solely, or so that a more effective degree of stain resistance of the carpet fabric is  
5 achieved at the same total of effective amounts of sulfonated aromatic condensate in said two steps as compared to the same amount in either step, solely.

18. The method of claim 17 wherein the dyed carpet fabric also comprises an effective amount of a  
10 fluorocarbon compound intended to improve resistance to soiling of the carpet.

19. The method of claim 18 wherein said second step aqueous solution also contains an effective amount of a thiocyanate.

15 20. The method of claim 18 wherein said aqueous solution of either or both application steps also contains an effective amount of dispersing agent.

21. The method of claim 18 wherein said aqueous solution of both steps also contains an effective amount  
20 of a salt having a divalent cation.

22. The method of improving exhaustion of a water soluble thiocyanate onto polyamide fiber comprising contacting said fiber with an effective amount of said thiocyanate at a pH between about 1 and 5 wherein said  
25 fiber has improved resistance to fading of dye due to strong oxidizing agents such as benzoyl peroxide or ozone, said dye being present in or on said fiber.

# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 88/01112

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>4</sup> : D 06 M 15/41		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC <sup>4</sup>	D 06 M	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X,Y	US, A, 4680212 (BLYTH) 14 July 1987, see calims; column 5, line 63 - column 6, line 24	1,2
Y	EP, A, 0235989 (DU PONT) 9 September 1987, see claims; page 1, line 24 - page 2, line 12	1
A	GB, A, 842634 (OWENS-CORNING) 27 July 1960, see claims; page 3, lines 67-70	1,6,7,21
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <div style="text-align: center;">24th June 1988</div>	Date of Mailing of this International Search Report <div style="text-align: center;">13. 07. 88</div>	
International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: right;">   <b>P.C.G. VAN DER PUTTEN</b> </div>	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

US 8801112

SA 21944

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/07/88  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4680212	14-07-87	EP-A- 0242496	28-10-87
EP-A- 0235989	09-09-87	AU-A- 6869287	20-08-87
		JP-A- 62223378	01-10-87
GB-A- 842634		FR-A- 1168270	
		US-A- 3039981	